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Child Behavior, Animal Behavior, and Comparative Psychology

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EDITED BY

Carl Murchison

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The Journal of Genetic Psychology, 1949, 75, 3-19.

A SURVEY OF EDUCATIONAL PROVISIONS FOR YOUNG GIFTED CHILDREN IN THE UNITED STATES, AND OF STUDIES AND PROBLEMS RELATED THERETO*

Hunter College of the City of New York

FRANK T. WILSON

A. PROCEDURE

During the spring of 1948 a brief questionnaire[1] of four questions concerning the education of young gifted children was sent to a rather wide sampling of colleges and universities which provide courses in the preparation of teachers, to over 100 of the large cities and to all of the state departments of education. The communications were sent to the Superintendents of Public Instruction or the special education officers, if indicated in the Office of Education Directory, of each state, and to the Superintendents of Schools in cities. They were addressed to Deans of Departments or Schools of Education, if indicated in the Office of Education Directory of Colleges and Universities, or otherwise to the Presidents of the institutions. A few additional individuals, whose names were supplied by respondents as persons doing interesting work in this field, were also circularized. These last were included in the group of city schools.

Table 1 shows the distribution of the questionnaire and the returns

TABLE 1
THE NUMBER OF QUESTIONNAIRES SENT OUT AND THE NUMBER AND PER CENT RETURNED BY THE THREE GROUPS OF SPECIALISTS

	Number sent	Number returned	Per Cent returned
Colleges and Universities	209	67	32
Cities and Schools	127	52	41
State Departments	48	20	44
Total	384	139	37

---

*Received in the Editorial Office on October 20, 1948.

[1] Professor Harvey Zorbaugh, Director of the Clinic for Gifted Children, New York University, and Professor Philip R. V. Curoe, Chairman Department of Education, Hunter College, assisted in the formulation of the questionnaire, and permitted the use of their names and titles on a covering letter sent with the questionnaire. The sheet on which the questions appeared was headed: *Hunter College-New York University Questionnaire Study On The Education Of Young Gifted Children.*

received up to August of 1948, according to the three groups of officials solicited. Two other respondents withheld permission to use their replies in the proposed publication of findings, and one other was incomplete and could not be used.

While the proportion of returns was less than was hoped for, it represents the thought and time of a large number of busy and responsible people all of whom, by inference, have had experience and responsibilities connected with the education of gifted children. It is of interest to note that the colleges and universities returned an appreciably smaller proportion of replies than either state or city officials.

The importance of the matter presented by the questions to the respondents is indicated by the care with which they answered and the character of many of the statements made. For example:

> ". . . . . . does not make as much provision for the needs of the specially gifted as it should."
>
> "Sorry, no material to offer; a neglected area with us."
>
> "The gifted child is certainly 'the forgotten man' in our educational system. Not only is he neglected; he is actually penalized for his ability to think and to achieve quickly. This situation constitutes one of our greatest losses in a civilization where ability is an asset and leadership a crying need."
>
> "It seems to me that we have a long way to go in adjusting education to gifted children. At the very point where appropriate education would pay biggest dividends, we have been slow to try to determine what sort of educational program and procedure is most appropriate for this group."
>
> "The under-privileged have received far more attention everywhere than the gifted."

B. ANALYSIS OF THE RETURNS

Replies to each of the questions have been treated separately. The statements of respondents were classified, after careful reading, into four categories, which seemed appropriate to their content. In many instances several statements were made by one person, and in those cases each different concept was considered separately. Where a statement was explanatory of the main idea, only the central concept was counted. They were placed in the categories according to the emphasis which it seemed was given by the writers.

The first category included statements which had to do with curricular provisions, either in content or procedure, and either theoretical or concrete. In all of these statements the emphasis which seemed intended by the writer was on curriculum.

The second category was used for statements which emphasized the individual nature and needs of children and included such concepts as growth and development, interests, abilities, case study techniques, individualized instruction, and the like. The emphases in all cases so classified seemed to be on the individual with not more than implicit reference to curricular provisions or to social considerations.

The third category was derived from those statements which recognized needs for study and development of socializing processes. The emphasis in each case was on the broader problems of human relationships, with the individual aspects of social needs implicit rather central.

The fourth category was used for statements that described strictly administrative measures other than either curricular matters or classroom techniques of teachers.

Attempts to classify statements, such as those just described, are not wholly satisfactory and it may well be that no one else would agree entirely with the classification the present writer has made. It is believed, however, that there would be substantial assent by most other persons who may critically consider the classification herewith presented, and that the conclusions proposed would generally be found in the data.

Question 1. What special provisions are made for these children in your school (s)? Please describe them briefly.

Table 2 shows that 61 per cent of respondents made statements about special provisions for gifted children existing in their schools. The proportion for the administrative officials in city and state systems was practically 70 per cent; that for colleges and universities somewhat less, 52 per cent. It would seem that the persons reporting felt that the need for special provisions was of decided importance, and that efforts were being made,

TABLE 2
SUMMARY OF THE NUMBER OF REPLIES TO QUESTION 1 BY GROUPS AND CATEGORIES

	Colleges and Universities	Cities	States	Total
Number received	67	52	20	139
Blank, "None," etc.	48%	31%	30%	39%
Returns giving statements	52%	69%	70%	61%
Number of classified statements	61	75	24	160
Per cent of statements re				
Curriculum	44%	24%	29%	33%
Individual nature, needs	36%	20%	8%	24%
Socialization	8%	12%	4%	9%
Administrative measures	11%	44%	59%	34%
	99%	100%	100%	100%

in many instances, to supply them. In fact, several respondents who replied, "None," added such phrases as, "Sorry to say," or "I regret to say." On the other hand there were some individuals who evidently felt otherwise, such as the chairman of a department of education in a college, who cryptically wrote across the questionnaire sheet: ". . . College not involved"!

One hundred and sixty different statements by respondents regarding provisions made by their institutions were found to be classifiable. Since it is presumed that many readers will be interested to know what is being done in this regard in the schools which sent replies, the substance of the statements is given according to each of the classification headings and for each group of respondents.

The colleges and universities made 27 statements (44 per cent of their replies to Question 1) in regard to curricular provisions, as follows: (*a*) general statements: "enriched program," 5; "extra," "special activities," 3; "occasional enrichment," 1; "variety of experiences . . . for youngsters of many degrees of talent," 1; "differentiated tasks in progressive activities," 1; "provisions room teacher makes," 2; and (*b*) more specific statements: "more difficult researches," 2; "more advanced supplementary readings," 2; "readings in library and at home;" 1; "more extensive work on units," 1; "rich, varied experiences in harmony with interests and abilities," 1; "enrichment in projects that challenge," 2; "projects in both school and community," 1; "additional reports, creative work," 2; "utilize as coaches," 1; "excuse from unnecessary and tedious instruction," 1.

Those from city systems and schools made 18 statements: (*a*) general: "enrichment within own grade," 9; "principle of environment," 1; "enriched experiences," 1; "teachers provide plenty of enrichment materials," 1; "curricular adjustments," 1; and (*b*) more specific: "enrich in quality and quantity of assignments," 1; "teachers know who they are and work with them," 1; "extra work," 1; "teachers encourage additional and other work," 1; "extensive supplementary materials," 1.

Reporters from state departments made seven general statements: "program," "curricular enrichment," 4; "most schools provide enriched program," 1; "as individual teacher makes the environment," 1; "some segregation with enrichment," 1.

The number of statements which were classified as concerned primarily with the nature and needs of individuals was a little less than those regarding curricular provisions, as shown by the percentages in Table 2. They were, briefed, as follows: 22 statements by college and university people:

(*a*) general: "discover and promote individual ability," 1; "additional development along lines of special interests, abilities, home background," "home conditions," "out-of-school interests," 3; "treat as individuals with individual needs," 1; "broader experiences in a few areas of special interests," 2; "make individual provision for individual student," 1; "instruction individualized," 1; "individual attention," 1; "provide for exceptional children," 1; "meet particular needs," 1; and (*b*) more specific: "encourage parents to supplement work of school, for example in language, drama, music," 1; "high quality work," 1; "use leisure time in creative work, for example, with art, playhouse, library table," 1; "self-assignments," 1; "teach habits and skills of self-diagnosis and management," 1; "expect more," 1; "added responsibilities," 2; "encourage variety of projects, materials to afford varying kinds of self-expression," 1; "self-selection in emergent curriculum," 1.

Fifteen statements by city school respondents were classified: (*a*) general: "on individual basis," 1; "individualized teaching," 1; "care for individual differences of all kinds," 1; "individualize instruction," 1; "adapt program to individual differences," 1; "activities along lines of individual interests," 2; "as much individualized instruction as possible," 1; "adjust work to needs," 1; "aware of these pupils," 1; "depends upon kinds of gifts," 1; and (*b*) specific: "musically superior children," "talented in art" "encouraged," 2; "differentiate work to challenge," 1; "additional work," 1.

Two statements of state persons were classified in this category, one general: "help teacher to better understand children, recognize individual needs", and one more specific: "challenge most able by special assignments."

Only 9 per cent of the total response statements were classified under the category of socialization provisions. Five came from colleges and universities: (*a*) general statements: "experiences involving leadership," 1; "participation techniques in emergent curriculum," 1; and (*b*) more specific: "experiences as committee chairman," 1; "planning periods to develop leadership, planning plays, handling visitors, publications, exhibits, leadership in clubs, programs," 1; "leadership within units—help librarian, in office, followership experiences, receive help from others," 1.

Nine statements made by city respondents were placed in this category: (*a*) general: "do not approve of segregation," 2; "opportunity class . . . a social working group," 1; "retain social group," 1; "develop leaders," 1; "program include social problems," 1; "enrichment classes on platoon plan, auditorium, play, etc.," 1; and (*b*) specific: "see he has a lot of rough and tumble sports with boys," 1; "activities along lines of current national or community interest," 1.

Only one statement was found from replies by state people to place in this category: "special class part of school as a whole."

There were 54 statements which were placed in the last category, administrative measures. They were distributed among the groups as follows: seven from colleges and universities as (*a*) general statements: "grouping by room teacher," 1; and (*b*) specific: "occasionally double promotion," 1; "if physically advanced cover tool subjects more rapidly and advance to next grade," 1; "advances as rapidly as ability permits," 1; "enroll in grade one a year earlier," 1; "ability groups for tool subjects," 1; "abundant resources of books and pamphlets," 1.

Thirty-three statements from city school people were placed in this classification. All seemed relatively specific, "grouping according to ability," "achievement," "special opportunity," "major-work," "intellectually gifted classes," "enrichment classes," 15; "acceleration and enrichment," "occasionally acceleration," "double promotion," 7; "survey," "individual tests," "cummulative records," 5; "balanced classes," 1; "special teachers," 2; "instruction manuals," "supplementary texts," 2; "work in skills in small groups," 1.

Fourteen statements by state people were in regard to administrative measures. Three seemed to be general: "by local systems," "superintendents." The remainder were more specific: "special classes," 3; "only in a few cases acceleration," 2; "extra promotion," "acceleration of more than one year not recommended," 2; "cosmopolitan grouping," 1; "study intelligence, achievement tests," 1; "special state certified teachers," 1; "handbooks and manuals," 1.

Summary comment on replies to Question 1. The special provisions as reported by the 61 per cent of respondents who made statements in reply to Question 1 seemed to be on the whole the familiar and somewhat controversial or vague provisions of special classes for all or part of the children's school work, limited acceleration, and enrichment in "regular," "balanced," or "cosmopolitan" groups. Emphasis in the statements was on the curricular side of children's school experiences, with much concern for individual needs. A small proportion emphasized socializing objectives of the special provisions, some of them being clear, fresh, and stimulating suggestions. Only one of the two state departments replying—Pennsylvania—reported provision of a special teacher certificates for gifted children. Two cities, only, mentioned specially chosen teachers, but made no mention of special license, certificate, or course training requirements. None of the colleges and universities mentioned any provisions for special training of teachers for this work in their institutions. Such training is, of course, commonly provided in such ways as in courses on exceptional children, including study of gifted children, by individualizing problems, and the like. It seems of some interest, however, that this matter of special training was not emphasized in any replies to Question 1 by college and university respondents.

Question 2. What experimental, or experiential, studies of these children have recently been made, or are now being made, in your school (s)? Please state the general nature of such studies, or give references to any published or otherwise available reports of them. If convenient, kindly send copies of any such reports.

TABLE 3

SUMMARY OF THE NUMBER OF REPLIES TO QUESTION 2 BY GROUPS AND CATEGORIES

	Colleges and Universities	Cities	States	Total
Number received	67	52	20	139
Blank, "None," etc.	79%	61%	60%	70%
Returns giving statements	21%	39%	40%	30%
Number of classified statements	13	22	11	46
Per cent of statements re				
Curriculum	31%	19%	9%	20%
Individual nature, needs	38%	45%	9%	35%
Socialization	—	—	—	—
Administrative measures	31%	36%	82%	45%
	100%	100%	100%	100%

Only 30 per cent of respondents gave information in reply to this question. It is understandable that modesty, and perhaps protection of interests, might cause some to refrain from mentioning work that was underway. The smallest percentage of statements came from college and university people, only 21 per cent giving information. In contrast, practically 40 per cent of city and state respondents had something to report. Perhaps the concern of college authorities for research production has stimulated school systems to out-smart the professors!

The 46 statements given in replies to this question were classified as for Question 1. None were found which emphasized, it seemed, primary interest in the socialization of gifted children. The relatively small number of replies makes it appear rather futile to break them down much further than is shown in the table summary for this question. Many replies were patently routine, for example: "workers of research department advise classroom teachers," study of "achievement and standardized tests," and the like. Others had the somewhat despairing ring so well known to researchers, such as: "Clinic records of 7,000 children—if only some way could be found to interpret them!"

The burden of interest for colleges and cities seemed to be in concern for what personally was happening to gifted boys and girls as a result of their school experiences, and in a still more vague way, what society was gaining or losing thereby. The general conclusion apparent from the replies is that not a great deal is being done at the present time in efforts better to understand the nature and needs of gifted children and society's stake in their education.

The state people gave 11 statements, nine of which were placed in the category of administrative measures.

Question 3. What special studies of children of this nature would it now be worth undertaking, if it were practicable to do so?

Unfortunately the wording of this question proved to be ambiguous, since some respondents evidently interpreted it to mean what studies their schools or institutions might make, and answered to the effect that none would at present be feasible. However, since other respondents made 141 suggestions, the analysis of the replies is offered.

Fifty-eight per cent of the respondents made statements that were classifiable. The distribution over the four categories shows a marked interest in socialization of gifted children, in sharp contrast to the small proportion of special concern in that area reported in answer to what special provisions were being made, and the absence of any reference to that area in reply to studies that have been, or are being, made. Interesting briefed statements given in reply to Question 3 and in the category of socialization of the children were: (*a*) from colleges and universities: "use of special abilities for the welfare of the group"; "how develop leaders without maladjustment"; "attitudes towards others and life"; (*b*) from city schools: "more stress on citizenship which functions"; "clubs that will give basic training in democratic leadership"; "emotional adjustment to social group"; "develop leadership techniques"; "evidence of leadership and how to foster different types of leadership"; and (*c*) from the states: "effect of segregation on attitudes and adjustment of the child"; "help teachers help gifted children make contribution to a world of average and below average people"; "what contribution do children make to group living?"

The number and proportion of statements made regarding curriculum in answer to this question were considerably smaller than was the case in Question 1. Perhaps this indicates that curricular problems are on the way to solution in the opinion of some respondents; but there is an insistent

TABLE 4
SUMMARY OF THE NUMBER OF REPLIES TO QUESTION 3 BY GROUPS AND CATEGORIES

	Colleges and Universities	Cities	States	Total
Number received	67	52	20	139
Blank, "None," etc.	46%	39%	40%	42%
Returns giving statements	54%	61%	60%	58%
Number of classified statements	56	54	31	141
Per cent of statements re				
Curriculum	20%	19%	19%	19%
Individual nature, needs	45%	31%	42%	39%
Socialization	21%	22%	26%	23%
Administrative measures	14%	28%	13%	19%
	100%	100%	100%	100%

call for help in such studies by others. For example, college and university people said: "What sort of program should be set up?"; referred to "materials and procedures for enriching," "democratic procedures for stimulating spontaneous use of abilities," asked "What enriching experiences?" The city suggestions included: "ways of meeting needs within the average class," "use of radio, visual aids," "enriched program," "additional suggestions for work." State officials emphasized "enriched curriculum," "practical suggestions to teachers," "help teachers help gifted children."

Thirty-nine per cent of the statements were in regard to the individual needs and nature of gifted children College and university people gave 25 suggestions that were classified under this category. Emphasis was on "development of potential resources," "special talents," "optimum environment for growth from early childhood," "develop horizontally," "how stimulate them to work to optimum capacity," and questions as to the nature of gifted children, such as "sex differences, health, appearance, home background," "relationship of accomplishment in different areas."

From the cities there were particular interests indicated in effects of acceleration, personality developmental histories, non-academic growth, motivation and guidance. The state replies also showed need for knowledge as to the nature of gifted children, their problems, methods of learning, and the effects of various educational provisions.

Question 4. What seem to you to be the main problems in the education of young children of superior mental ability?

The greatest number of statements in replies to the four questions, 191, was given in answer to this one. Since the formulation of problems is recognized as central to good thinking and to practical measures in meeting life situations, a somewhat detailed analysis will be presented as to what respondents gave as main problems in the education of young gifted children.

Only 29 per cent made no comments, most of these merely leaving the answer space blank. A very few wrote "None." Seventy-nine per cent of the officials in city schools who returned questionnaire answers gave statements on this point, that proportion being 13 per cent more than the percentage of college and university persons. It seems reasonable to presume that administrative officials, concerned with the conduct of their educational programs, would be sensitive to problems in this area. At any rate, it was evident that they, and the college and university professors perhaps only to a slightly less degree, were well aware of problems in this field.

The distribution of the statements of problems as classified under the four headings for all respondents taken together, was quite even, as shown in Table 5. In the opinion of the state officials, however, administrative problems appeared much more important, 45 per cent of the statements for this group being so classified. For the city school people problems of individual growth and development seemed insistent. Among the college and university respondents the curricular problems were somewhat more numerous, but the four categories showed approximately equal mention. In all the groups there seemed to be an increase in concern regarding the socialization of gifted children over the proportions indicated by replies to Questions 1 and 2.

TABLE 5
SUMMARY OF THE NUMBER OF REPLIES TO QUESTION 4 BY GROUPS AND CATEGORIES

	Colleges and Universities	Cities	States	Total
Number received	67	52	20	139
Blank, "None," etc.	34%	21%	30%	29%
Returns giving statements	66%	79%	70%	71%
Number of classified statements	87	73	31	191
Per cent of statements re				
Curriculum	32%	14%	19%	23%
Individual nature, needs	19%	42%	19%	28%
Socialization	25%	15%	17%	20%
Administrative measures	24%	29%	45%	29%
	100%	100%	100%	100%

A sampling of the briefed statements of problems suggested by each group of respondents follows. College and university people made 21. Eight referred to teachers, such as "informed," "adjusted," "trained," "teachers knowing how," "adept to provide enriched program by individual differences," "with vision," "who recognize possible shortcuts children can 'take . . . insights which should be expected," who recognize "conceptual development as orderly procedure and use of this as a directive." Three noted need "to discover" gifted children "early," and 8 indicated need for "materials," "equipment," "facilities," "time," "money," and "staff." The remainder mentioned "red-tape, lock-step," and "acceleration."

Twenty-one statements were made by city school officials. Nine of these referred to teachers, such as "equipped," "fine," "trained," "teachers who have ability," "vision," and "energy." Nine others had to do with "budget," "class load," "materials," "space, time and personnel," and three mentioned "type of organization," "early identification," and "education of parents and public."

Of the 14 statements by state officials seven were regarding teachers—"teacher education to recognize both normalcy and potentialities and to provide enrichment and guidance," "teachers sensitive to needs," "understanding," "trained." Three spoke of "materials," "equipments," and "instructional aids," and four indicated "small classes or schools," "environment," "expensive set-up," and "teacher time."

Apparently the key to the over-all problem in the thinking of the people in all three groups is a trained teacher. This seems quite suggestive since practically all respondents omitted, in their replies to Question 1, any reference to the training of teachers for this particular work, when describing the special provisions for gifted children existing in their educational programs.

Question 5. If you know of interesting work being done elsewhere in this area of "gifted" children please indicate to whom we may send a copy of this questionnaire.

This was a question designed to discover names of people and places where special work might be in progress but about which little was known. The question did produce several references. Table 6 gives a summary of

TABLE 6
SUMMARY OF REPLIES TO QUESTION 5 BY GROUPS AND CATEGORIES

	Colleges and Universities	Cities	States	Total
Per cents giving references	24%	25%	40%	26%
Number giving				
1 reference	8	5	3	16
2 references	2	4	2	8
3 references	1	3	2	6
4 references	0	0	1	1
5 references	5	1	0	6
Totals	16	13	8	37

replies. Only 26 per cent of respondents gave answers to this question. Doubtless many considerations besides lack of knowledge contributed to the rather small return, such as pressure of time for answering the questionnaire, inability to recall names or exact addresses, and others. On the face of the tabulation in the table, however, it would seem that there is not much special work underway in this field.

The state people gave the highest percentage of references, as might seem understandable, since they survey their states and should know what is going on educationally in them.

C. CONCLUSIONS

The main impressions gathered from study of the replies may briefly be stated as follows:

1. There is a strongly felt need for: (*a*) curricular materials and procedures, primarily for enrichment in regular classes; (*b*) trained teachers, who understand the nature and needs of gifted children, who appreciate them, and have special skills to guide their growth and development in social living; (*c*) more information about the nature of gifted children.
2. Apparently findings concerning gifted children well established by many research studies have not reached large numbers of school people, who have concrete problems of providing educational experiences for gifted boys and girls.
3. The two conclusions given above point to needs apparently not generally recognized by teacher training institutions.

D. THE CONTROVERSIAL QUESTIONS OF SEGRATION AND ACCELERATION

There was a clear trend of thinking shown in the replies regarding segregation that was definitely suspicious of special class provisions for gifted children. Again and again respondents specified practices or needs for provisions for superior children "within the average or regular class." This position, in some cases, was justified by references to democratic aspects of education. In other cases the concern was more a matter of the personality development of gifted children which, it seems, was thought to be threatened by "wrong attitudes," "snobbishness," social "maladjustment," and the like, if gifted children were subjected to segregation.

Pasadena, California, was reported by the Consultant, Elementary Education, State Department of Education, to have "discontinued its special school for gifted children and should have material supporting that decision." Chicago school administrators believe that "individual education for all children will provide for the gifted in the natural social situation without segregation."

On the other hand many respondents reported provisions such as homogeneous grouping and special classes. Notable among these were the Major-Work *classes of Cleveland, the X, Y, Z plan in Detroit, the Opportunity* rooms of Los Angles, and classes for Intellectually Gifted Children in New York City.

The controversial nature of *the* best plan for providing for gifted children was recognized by several persons who proposed matched pupil studies to compare the outcomes of the education of these children by the three typical provisions of special classes, definite enrichment within regular classes, and education in regular classes without extensive and systematic enrichment.

In regard to acceleration there were also opposing trends of thought. Many wrote definitely against any acceleration, several against more than one year advancement. The reasons seemed to be based on fears that the children would be socially or emotionally harmed. On the other side of the question were many who reported double promotion practices with no objections raised, while still others mentioned the likelihood of poor work habits, attitudes of boredom, behavior problems effects, and the like, if these children are forced to remain with their age groups.

The State Teachers College of Montgomery, Alabama, was reported: "Formerly we tried the method of enrichment. This created certain problems of materials as well as parental coöperation. We find that to allow pupils to advance as rapidly as their ability permits is a most satisfactory plan."

E. IMPLICATIONS IN THE REPLIES ABOUT WHICH SOME CONCERN SEEMS INDICATED

Certain implications found in the returns raise questions of concern as to the possible harm their application might bring to gifted children. One such implication has to do with the needs of gifted children as growing children. For example, some respondents emphasized emotional and social development "commensurate" with mental abilities. The degree of precociousness in *various areas of development seem not always to be commensurate in normal* growth. Perhaps they should not be so. As one respondent has put it, what the gifted child needs is "rough and tumble" play—not as a different sort of creature, but with other children as a child, with noise, puppy-fun, and abandon. The hygienist warns that adolescent difficulties tend to increase if the early childhood and preadolescent behavior is aborted.

Another cause for concern is the over weighting of intellectual activities, such as reading, advanced study, private lessons in languages, music, and the like, with a minimizing of child emotional and socializing experiences. The intellectual thus may become substitutive and compensatory, rather than whole-hearted, fundamental sort of experiences, which genuinely integrate development for maximal social adjustment, and thereby, for usefulness.

On the other hand, there were implications in some replies to the effect that mental development should be held back, or at least that guidance of growth of the gifted should be emphasized in other areas, rather than in the mental. The cautions to make sure of "continuity" rather than variety, of "thoroughness," instead of exploratory sampling of environmental opportunities, seem not quite in accord with the understanding of the more desirable nature of rich and varied growth. As Carlson (1) says of the needs of the gifted child: "Can we not somehow let him learn at his own rate of speed?" (just as we insist is best for the slow learner.) And, "The present writer believes the whole question of rapid learning in this sense needs to be reopened and reconsidered in the light of our present knowledge of child psychology." To force the fast learner to slow his rate of intellectual development—the very aspect of his nature that most clearly distinguishes him from his fellows—may be detrimental to his growth in profoundly basic respects.

A fourth matter of concern implied in many responses and implicit in still others, is insistence that gifted children be limited largely in their school associations to "cosmopolitan," "regular," or "homogeneous" groups. The reasons seem bound up in the belief that in a democratic society bright and dull, moron, average and gifted must learn (joyfully?) in common association. While something may well be said in favor of much of such common experiences yet, as some respondents recognized, the paucity of mental stimulation for one or two gifted children spending their school careers with others (even some teachers) who think and appreciate on a level 50 or so points lower on the intelligence scale, promises little in the way of democratic virtue. For most gifted children their distinctive characteristic is extraordinary mental ability. Even the prodigious athlete is perfected, not by weaklings, but by the peers with whom he trains and competes.

Evidences of the need for such extensive associations of like minded individuals are truly replete in psychological and sociological literature. Children tend to choose friends of approximate equal mental age. Vocational "levels" are related to mental ability, and within such groups the dull tend to enjoy the dull, the more able to seek their peers. In matrimonial adventure matches tend to be of pairs not too different in mentality, and there is some evidence that the more stable matings tend to be of those more rather than less comparable in mental abilities. We may do harm to deny the gifted mind much life experience with like-minded peers.

F. IMPLICATIONS IN THE REPLIES THAT POINT TO PROGRESSIVE INTERPRETATIONS

Among many replies were implications of modern educational theory as that most rightfully needed in the education of the gifted. In the philosophical approach gifted children are to be educated for a genuinely "democratic society," free and humanitarian in character. Differences among individuals shall be understood, appreciated and utilized for "social ends." Individuals shall enjoy full growth in body, mind, and social and emotional natures. This full growth rests upon functional patterns of behavior "emerging from self-selected experiences of every kind." Of necessity, thereby, "the whole school" and also "the community" are intimately associated in the educative processes.

The curriculum, both as to goals, content, and method, is to be based upon "experiences of living in a social world," "understanding the nature of child growth and development," the "acceptance" of children, and their guidance by teachers who are friends. Situations are to be permissive, allowing children time, "self-selection," and management of their affairs—which means "participation in planning," "carrying on," and "evaluating experiences," and hence is dominated by "interests and abilities" of children. "Life situations" will be the central content in the curriculum and will "identify and provide those experiences in which learners need help." They will be both "horizontal" and "vertical" in scope, and resources for their exploitation will be abundant. "Continuity of progress" *in development,* rather than "graded standards," will be sought.

To achieve this educational provision for gifted children the two disiderata already mentioned, are clearly emphasized: understanding teachers, trained to guide the growth of the gifted child; and materials of content and method appropriate to the emerging levels and areas of their growth.

"The problem will in the future, as it has in the past, advance toward solution as the gifted educators of one generation more and more unfailingly find, and more and more adequately educate, the gifted educators of the next" (2).

TABLE 7
DISTRIBUTION OF REPLIES RECEIVED BY STATES AND GROUPINGS OF RESPONDENTS*

	Number of responding			
	Colleges and Universities	Cities	State Departments**	Total
Alabama	2	2		4
Arizona	2		1	3
Arkansas	1			1
California	3	3	1	7
Colorado	1	1	1	3
Connecticut	1			1
Delaware	1	1		2
District of Columbia	2	1		3
Florida	1	1		2
Georgia	1	1	1	3
Idaho				0
Illinois	2	1		5
Indiana	2	2		4
Iowa	1	1		2
Kansas	1		1	2
Kentucky	1	1		2
Louisiana	1	1	1	3
Maine			1	1
Maryland	1		1	2
Massachusetts	3			3
Michigan	1	1		2
Minnesota	1		1	2
Mississippi	1		1	2
Missouri	1	1		2
Montana	2			2
Nebraska		1		1
Nevada	1	7		8
New Hampshire	2	1	1	4
New Jersey	2	3		5
New Mexico	1		1	2
New York	2	7		9
North Carolina	1	1		2
North Dakota	1		1	2
Ohio	2	3	1	6
Oklahoma	1			1
Oregon	1	1		2
Pennsylvania	5	3	1	9
Rhode Island	1	1		2
South Carolina	1			1
South Dakota	1			1
Tennessee	2			2
Texas	2	1	1	4
Utah		1	1	2
Vermont			1	1
Virginia	2	1		3
Washington	1	1		2
West Virginia	1	1	1	3
Wisconsin	1			1
Wyoming	1	1	1	3
49	67	52	20	139

*Every state but Idaho was represented among respondents.

**One other state department respondent refused permission to use his reply for publication, and another offered to reply if an additional form were sent, which unfortunately was not done.

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THE THREE-AND-A-HALF-YEAR OLD*

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A. Introduction

Earlier study of preschool children as we have observed them in nursery school play (7), in the developmental examination (4), and as their behavior is reported by their parents in the detailed behavior interviews which accompany the developmental examination, has made it evident that not only does each child appear to have a characteristic constitutionally determined individuality which first expresses itself in infancy and which continues to appear consistently throughout the preschool years (and presumably thereafter), but that in addition *each age level* has a characteristic pattern of its own which is consistent from child to child. Thus the behavior of any given child at any given age is colored partly by his own basic individuality, and partly by the pattern of his age level.

This pattern does not consist so much of what the child can accomplish, as it does of *the way in which he behaves*. The 2½ year old, for example, is found to be characteristically

> "in a transitional period. He has to do a great deal of intermediating between his own contrary impulses. . . . He expresses himself in terms of opposite extremes because his command of Yes and No, of Come and Go, Run and Stop, Give and Take, Grasp and Release, Push and Pull, Assault and Retreat is so evenly balanced. Life is charged with double alternatives. Every pathway in the culture is a two-way street to him, because he is most inexperienced. . . . His action system likewise is a two-way system, with almost equally inviting alternatives, because he is so immature. His equilibrium is unstably balanced, because his inhibitory mechanisms are very incomplete. Moreover life and environment are so complex at this transitional stage that he is almost obliged to go *both* ways, to experience both alternatives so that he may find out which is really the right one.
>
> "His capacity for voluntary choice is weak; so he chooses both alternatives, not because of downright stubbornness, but because he lacks facility in balancing alternatives and of thinking of one alternative to the exclusion of another. . . . He does not have his flexor and

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> extensor muscles in check and counter check. He tends to grasp too strongly and he releases with over-extension. He has not learned to let go. He has difficulty in relaxing readily to go to sleep. And when he sleeps he may show a tendency to sleep too much. Similarly he may not easily release the sphincters of bladder control and so he withholds elimination too long. . . .
>
> "The peculiar limitations of his action system, therefore, account for his characteristic inability to *modulate* his behavior. He has such difficulty in making transitions that he tends to dawdle as though it were hard for him to go from the familiar to something different. He is so conservative that he combats innovations. He wants to have things done the accustomed way. Sometimes he is actually a ritualist, particularly at home, and insists on having things *just so*. On these occasions he may be so insistent that he seems positively imperious. . . .
>
> "Nevertheless his adhesiveness, his vacillation, his oscillations between extremes are temporary. By the age of three he will amaze us with his conformance, his desire to please, his interest in making not two choices, but one.
>
> "It is relatively normal, from a developmental standpoint, for children to show to some degree the extremes which have been suggested,—the sudden shift from intense activity to passive acquiescence accompanied by transient thumb sucking; shifts from exuberance to shyness; from keen desire to possess an object to indifference when it is possessed; from clamor for food to rejection of it; from shriek and scream to whispering and monotone; from herd-like imitativeness to shrinking isolation; from laughing to whining; from precipitateness to dawdling. . . . Two-and-a-half is the paradoxical age" (7, pp. 177-201).

There appears to be a tendency for ages when the child may be characteristically "in equilibrium" to alternate somewhat rhythmically with ages when he may be said to be "in disequilibrium." This alternation is in accordance with the principle of reciprocal neuromotor interweaving (2). Outstanding ages of disequilibrium, described previously by us (7), have been considered as: 15 months, 21 months, 2½ years.

Subsequent analysis, parents' increasingly detailed reports (as parents became more and more familiar with the developmental point of view), and most of all, the large number of children of this age who have been referred to us by parents worried about the typical manifestations of this age, have led us to believe that a significant age level has not been sufficiently delineated. Three-and-a-half years (42 months) appears, as an age level, to have as clearcut an individuality as any of the other disequilibrium ages which have previously been described.

Some 210 three-and-a-half year olds made up the group of cases whose behavior was studied here. These children were for the most part of the upper middle class, of superior intelligence, and within normal limits so far as personality and home and school adjustment were concerned.

As with other preschool ages described in *Infant and Child* (7), no numerical or tabular treatment of data is attempted. We shall merely present descriptively the constellation of personality and behavior traits which in our opinion characterizes the age level of 3½ years, which falls between the 3-year-old period of relative equilibrium and conformity and the "out of bounds" behavior commonly occurring at four years. As in the case of other age levels described in earlier publications, *not all children exhibit the behavior described at exactly the age level designated.* Thus a more mature child might exhibit this characteristic three-and-a-half year old behavior as early as three years of age; a less mature child might not reach it until four years of age. But in either case this characteristic constellation of behavior traits would come *after* the smooth period commonly observed at three, and would *precede* the 4-year-old out of bounds behavior.

B. OUTSTANDING THREE-AND-A-HALF YEAR PERSONALITY TRAITS

1. *Physical Incoördination*

There is much stumbling and falling. Lack of smooth interplay between flexors and extensors results not only in gross motor incoördination as evidenced in stumbling and falling but also in a marked hand tremor in many children. Some mothers feel that the child is "going to pieces" his coördination is so poor. Drawing products are now characterized by a thin wavery line instead of by a clear bold stroke as earlier.

2. *Fear of Falling and Fear of Heights*

The child shows marked fear of falling even in such simple and customary activities as going upstairs. There may be a reiterated demand of "Hold my hand." Fear of falling may be based on the fact that there is so much falling. Fear of heights may be associated with poor coördination, and may be partly visual.

3. *Shift of Handedness*

An outright shift in handedness often occurs at this age. Thus the child who has been using his right hand exclusively may now shift to his left, or vice versa. The combination of shaky hands and confusion about handedness often causes some trouble about eating and dressing, particularly if the child is tired. Tears and anger at mealtimes or when the child is dressing often result.

4. *Excessive Tensional Outlets*

This is an age of many and intense tensional outlets. Not only stuttering but eye blinking, nail biting, thumb sucking, nose picking, rubbing of genitals, chewing at garment or sheet, excessive salivation, spitting, tics, and simple compulsive patterns occur. The frequent whining which occurs at this age may also be considered a tensional outlet.

5. *Stuttering and Other Speech Difficulties*

If the child has stuttered earlier (at 2½ years) there may be a return of this behavior. In slow-speech children the first stuttering often occurs at 3½ years. Voice tremors are common and voices are often more highly pitched than earlier. Loud voices are particularly characteristic in the nursery, but in contrast, in an examination situation a child may whisper throughout the examination and may respond only when whispered to.

6. *"Psychological Deafness"*

Parents frequently report that their children are becoming deaf because the children do not respond even when addressed repeatedly. However, hearing may actually be very keen at this age. Whispering is often a good motivator when they will not respond to things spoken in a normal tone. There are many auditory fears. Deafness may be a hyper-auditory awareness of something else than the remark directed to the child.

7. *Visual Difficulties*

Similarly, a frequent complaint of the children themselves, for instance in story reading when the entire nursery group is looking directly at the book, is "I can't see." This may even become a group chant, but the first complaint is usually made by a child sitting directly in front of the book. This inability may represent a real difficulty in handling the intermediate visual zone, which characterizes many children at this age (5). Three-and-a-half-year olds when holding their own books commonly hold them very close to their eyes.

8. *Difficulty with Spatial Orientation*

This is noted particularly in the examination, when base cubes of the three-cube bridge, which have been placed correctly at three years, are now separated too widely. This difficulty probably has both a visual and a motor basis (5).

9. *Emotional Insecurity*

The child seems to feel extremely insecure emotionally. Parents often feel that the child is "insecure." The child seems to be much concerned about the parents' attitude toward him. He asks his parents frequently, "Do you love me?" He does not allow parent to laugh at him. The child's feelings are easily hurt, particularly when he is excluded by contemporaries in play. Nighttime requests for lights on and doors open frequently begin at this age, and nightmares are sometimes reported.

10. *Adult-Child Relationship May Be Rather a Problem*

Child may be very commanding and demanding with all adults, not just with his parents. He commands, "Don't talk," "Don't laugh," "Don't look at me." He may alibi but is not usually openly defiant. He may be shy with adults. In disputes with other children, however, he still calls for help from the adult. He may still accept the adult more or less as a contemporary and still wants the approval of the adult even though he is demanding of him. Children are so insistent on having the full attention of the adults focussed on them that they may object to the parent reading the paper, for instance, or talking to the other parent.

11. *Self-Protectiveness*

The child is quick to protect himself with "No" or "I can't" if he thinks a situation is going to be too difficult for him. He may protect himself, by isolation, from too many failures. Also at this age his feelings are easily hurt and he is easily inhibited.

12. *An Age of Emotional Extremes*

In a new situation with an adult a child may at first be extremely shy, but as the situation progresses he may become very exuberant and boisterous.

13. *An Age of Marked Expressions of Affection*

Affection is often expressed in kissing. There is also a marked interest in weddings and a wish, expressed, to marry the parent.

14. *Importance of Friends*

Friends are very important but children are very new and unskillful about friendships. At three the child often seems to like and to get along with a whole group, somewhat indiscriminately. At three-and-a-half, there is the beginning of friendships for special people. These friendships may consist merely of sitting beside the chosen child. Or they may include verbalization and delicate, tentative, wishing-to-please overtures such as: "May I play with you?" "Would you like to do this?" There may be excluding of some other child: "We don't like him, do we?" Strong feeling of togetherness with other children is expressed by use of such words as "we" or "we both." Though frequently these friendships are between two children of the same sex, heterosexual friendships, with girls definitely the aggressors, are often characteristic of this age level.

The query, "Do you love me?" which is so often addressed to parents, may also be addressed to contemporaries as in the case of the child who asked another, "Do you love me like Karen?" only to receive the reply, "Yes I love you like carrots, I love you like spinach, I love you like cabbage."

15. *Effort to Achieve Finer Control*

The child is trying hard for finer control than he has achieved earlier, and he is often exhausted and frustrated by his efforts. In block building, for instance, he may try so hard to be extremely accurate that he fails in building tasks which he could accomplish successfully earlier. Similarly in social relations he is trying hard for finer control.

16. *A Solo Age*

This is a solo age in spite of the interest in other children. Children often want to stay alone rather than with the group. May want to sing alone or be read to alone.

17. *Highly Imaginative*

Children are highly imaginative at this age, which is the high point for imaginary companions. The amount of this play varies from child to child. Some have only one such companion, and play with him now and then. With others, the entire daily life of the child (and of the family) may be pervaded with these companions. One child may for instance have several imaginary animal companions, and several different human companions and may also play, himself, the rôle of an animal and/or of another person, and may also personalize objects (1). Imagination is also expressed in dramatic play with blocks, housekeeping materials and also in work with art materials.

18. *A Developmental Spurt*

This age frequently marks the beginning, particularly in boys who have been slow to develop and who have run a somewhat atypical course up to this time, of a developmental spurt in which behavior for the first time becomes well-rounded and well-organized and up to age expectations.

C. Nursery Techniques

As in the case of other preschool age levels described in *Infant and Child* (7), we have drawn up a summary of Nursery Techniques which we believe will be found useful for the nursery-school teacher in handling children of the three-and-a-half-year age level. These techniques are not, of course, determined arbitrarily by the teacher, but rather have been worked out carefully as best suited to the behavior maturities and immaturities of the child of this age level. Therefore the techniques themselves give us information as to the age level. We have included techniques useful in relation to physical environment, adjustment, routines, transitions, teacher-child relations, verbal behavior, child-child relations, and group activity.

1. *Physical Environment*

Physical restrictions now play a small part. The major effort of the teacher, so far as environment is concerned, should be in varying the physical set-up. She may even go so far as to change the whole room around from time to time—moving the doll corner, dividing the room with large blocks, setting up a library in a different corner. This will often stimulate new and interesting activity.

2. *Adjustment*

Because of the child's shyness at this age, initial adjustment may have to be handled through the indirect approach, such as mentioning his clothes, or through familiar "surprises" or favorite toys.

3. *Routines*

By this age children can accept shifts in routine, as for instance having milk and crackers at various strategic spots around the room or even informally in the midst of play instead of always at the table. For instance, children may eat while sitting on their block buildings or while playing in the doll corner.

Rest can be varied by having them sit and listen to music or to stories; or by having part of the group—those most in need of complete relaxation—rest on cots while the others merely engage in some quiet activity. At this age the children do not object to such discrimination, and do not mind resting when some of the others are not required to.

Requirements about cleaning up the room may be varied depending on how the day is going. On some days it may be more important to shift the play to some new activity rather than having the children put away all the toys.

Often at this age the more capable children are able to help the less capable with routines.

4. *Transitions*

For the most part transitions do not present a very difficult problem. However, friends often insist on doing things together, and friendship can be used, if necessary, to effect transitions.

Whispering such suggestions as "It's your turn to wash now" is usually very effective.

A useful technique is to vary the simpler "It's time to wash hands now" by saying, "Let's see your hands" and then after inspecting, adding, "Yes, they need washing."

5. *Teacher*

For many children in this age group some one teacher is often very special and important. The child's relationship to the teacher at this age is characterized more by admiration and friendship than by attachment and dependence as earlier. A special teacher may be particularly successful in handling the child who admires her. Children, however, are quickly aware of the less experienced teachers who are often vulnerable to teasing, and a novice may profit by getting her first experience with another age group than three-and-a-half.

The skillful teacher can often build on the imagination of the child of this age by assigning him an imaginary rôle or even by occasionally entering into his imaginary play.

Though the social imitative "me too" began at three, it is even stronger at three-and-a-half. It is very important, therefore, to point up the more positive factors in the group behavior as worthy of imitation rather than mentioning negative factors. If a leader is requested to do something, the rest of the group will generally follow, thus giving the group coherence.

Although it is often helpful to encourage the friendships which spontaneously arise, some friendships will appear to be detrimental to one or both children or to the group, and will need teacher-planned separation or constant supervision.

6. *Verbal*

The three-and-a-half enjoys talking, and the teacher must be skillful in taking part in conversation and in presenting new ideas and new information. But she must be equally skillful in terminating or shifting the conversation when its positive values are exhausted. Lunchtime affords a particularly good opportunity for a guided conversational experience.

Whispering is a very effective mode of communication.

The teacher's use of such favorite words as "different," "surprise," "guess," etc., can be very successful.

7. *Other Children*

Friendships are very important to the child but not always well handled by him. The teacher may need to give considerable help not only in smoothing out relationships, but in separating combinations which are not constructive, and in building up friendships which may be beneficial.

Just as special friendships are beginning, so also do we get the beginning of verbal excluding. The frequent refrain of "You can't come in" may be unduly frustrating to the more sensitive child who is not ready to accept exclusion or the substitution of another activity. In these situations the child may be accepted if the teacher helps with the following suggestions: (*a*) With a light tone of the positive, "She can come in," sung on a minor third. (*b*) With a choice as "Do you want her to bring you some bread or some butter?" (*c*) With a widening of their horizon by a new word or new concept as, "You could invite her to be your *guest*," or "Show her where she can ring the doorbell before she comes in." (*d*) With use of the specific, "But this is the postman bringing you some mail" (7).

8. *Group Activity*

As at two-and-a-half, group behavior is quite unpredictable, some days being very stormy and others showing remarkable glimmers of four-year-old coöperation and imagination. It seems hard for the child of this age to impress himself on his contemporaries, and he often seeks to do so by grabbing a favorite doll or carriage or other toy. This does not usually have the favorable effect he hopes for.

Group activity is characterized by the formation of strong friendships and discriminating against the rest of the group, demanding and commanding each other and resorts to hitting and pushing.

During a difficult period a group of three-and-a-half-year olds is frequently better organized if it is divided into smaller units, or if more planned activity is introduced (7).

D. Summary

Earlier developmental studies have yielded characterizations of many of the preschool age levels, namely 18 months, 2 years, 2½ years, 3, 4, and 5 years, which have presented a personality picture of each of these ages. Hitherto no separate characterization has been made of the 3½ year age level.

However, the large number of three-and-a-half-year old children referred to our clinic because of behaviors worrisome to parents, has led to a detailed investigation of this particular age level. Three-and-a-half appears, on close investigation, to have an individuality as clearcut as any of the other preschool ages; and appears to differ conspicuously from the preceding and directly following age levels of three and four years.

Briefly, three-and-a-half years appears to be characterized by the following kinds of behavior: Physical incoördination; shifts of handedness; fear of falling and fear of heights; excessive tensional outlets; stuttering and other speech difficulties; "psychological deafness"; visual difficulties; difficulty with spatial orientation; emotional insecurity; difficulties in the adult-child relationship; excessive self-protectiveness; emotional extremes; marked expressing of affection; great concern about friendships; efforts to attain finer control both in motor functions and in social relationships; desire to do things alone; marked imaginativeness in play. There also occurs in some children who have, up to this point, developed slowly and somewhat atypically, a marked developmental spurt which may bring behavior in all fields up to the average for the age.

On the basis of behaviors observed to be most characteristic of this age level, particularly as the child plays in the nursery school, a series of nursery techniques have been drawn up, which may not only be of practical use to teachers dealing with three-and-a-half-year olds, but which in themselves supplement our picture of behavior at this age. Techniques described include those which deal with physical environment, with adjustment problems, with routines, with transitions, with teacher-child and child-child relations, with verbal handling of the child, and with group activity.

Previous observations have indicated that, during the preschool years at least, ages when the child is basically "in equilibrium" appear to alternate somewhat rhythmically with ages when he appears to be largely "in disequilibrium." Although hitherto no separate characterization has been made of the 3½-year old age level, it now appears that a clearly distinguish-able three-and-a-half year old period of disequilibrium intervenes between three and four years, and that tensions, indecisions, "insecurities" and similar behaviors commonly observed at this age are not individual aberrations but predictable behaviors which normally characterize this age level.

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DOMINANT AND SUBMISSIVE BEHAVIOR IN PUPPIES AS INDICATED BY FOOD INTAKE*

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A. The Problem

Experiments by the author have shown that a social hierarchy forms among most litters of dogs (3-4). At the tops of the social orders are the extremely aggressive animals which dominate all the others. At the bottom of the hierarchy are those which are extremely timid and inhibited in the presence of other dogs, and are dominated by all members of the group. Between these two extremes, there is a third, termed mid-group, which dominates the submissive animals. These mid-termed groups of dogs are in turn dominated by the aggressive animals, but still seem to get along well together. There is little antagonism among the members of this group. The above relationships were worked out mainly in competitive food taking experiments.

The position of the dog in the hierarchy seems to effect his performance and behavior in almost every situation. It has been shown, for example, that the conditioned salivary reaction of the timid dog is inhibited by the presence of the aggressive members of the litter. In the mating reaction, the aggressive dogs have a decided advantage. They are able to make a more rapid and satisfactory adjustment to almost any situation. They are not as disturbed in the presence of strange people or other dogs as are the timid or mid-group animals.

The above mentioned experiments were done with mature animals. During the summer of 1947 a study was made with a litter of puppies at the Jackson Memorial Laboratory, Hamilton Station, Bar Harbor, Maine, in an attempt to determine just how early in the life of the puppies these differences appear, and to see if the differences remain the same until maturity. Besides observing the development of differences in aggressiveness and the effect of the differences on the behavior of the puppies, an attempt was made in one

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part of the experiment to increase the aggressiveness of the timid dog by the use of alcohol.

The animals used in the present study were four Dalmation-setter F 1 hybrids, one female and three males, which were born on April 2, 1947. The puppies had remained together since birth. The experiments were started on June 28, when the animals were 85 days of age. The animals were observed daily throughout July and August, and then transferred to the University of Georgia, and there they were observed at intervals until maturity.

For the first week of the experiment the puppies were observed during the daily feeding periods in their kennel. The food was put into two rather large pans which were placed on the floor of the kennel. It was observed that three of the puppies took most of the food. The fourth dog, Red, ran from pan to pan, snatching a bite of food when it could, but was usually pushed away from the pan by the other three dogs. It was evident at this early age, 85 days of age, that a dominance difference had been established.

B. Competitive Feeding

To get a more accurate picture of the dominant-submissive order, the animals were fed in a competitive feeding situation. A food pan was placed in a square wooden box with a small hole in the top so that only one dog could eat at a time. The cover of the box could be pulled open by a string.

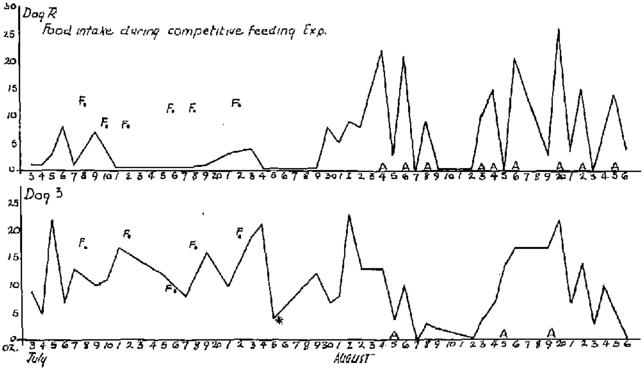
The feeding box was placed in the center of the experimental room, with the area surrounding the box marked off in circular zones. The box was in the center of Zone 1, a circle with a three-foot radius. Other zones were marked off by circles with radii of six and nine feet, giving Zones 2 and 3 between the perimeters of these circles, with Zone 4 covering the area between the last circle and the walls of the room. In this manner the position of each animal could be determined at any time during the experimental period.

The experimental feeding was done in the early morning when the dogs had vigorous appetites. In order to be sure that they would all be hungry during the entire feeding period, about half their normal ration was given during this period. This amounted to about four pounds of wet food. The experimenter remained in the far corner of the room, and after all the puppies had gathered around the box, the top was opened, and the dogs would compete to get the food. It was observed that the dominant animals remained in the vicinity of the pan most of the time during the eating period, therefore, on certain days the position of each dog in the various zones was noted every 10 seconds while food was in the pan. It was assumed that the dominant dog would get into the pan first, or if not, would be able to force the less dominant animals out of the way. The dogs were weighed before and after feeding to determine which dog ate the most during the period.

C. Food Intake and Dominance

The general over-all picture of the relationship between food intake and dominance may be indicated by the composite graphs in Figures 1 and 2. These graphs show the food intake in ounces during each competitive feeding period through July and August. The picture of the behavior throughout July shows how the animals rated at the beginning of the study. During this time Dogs *V* and 3 seemed to be about equal in dominance, and they ate about the same amount of food during each experimental period. Dog *R* was definitely the dominated animal. This animal had difficulty getting into the pan, and when he did do so, was easily forced out by any of the other animals. As the record shows, Red seldom got into the food pan during these periods.

In order to compare the amount of food eaten in the experimental period with what the animal would normally eat when fed in the kennel, the dogs



*Dog fight-Beaten by V.

FIGURE 1

This figure shows the food intake in ounces during the experimental periods through July and August in Animals *R* and 3. *F* indicates the food intake when the animals were fed in the kennel. *A* indicates the food intake following doses of alcohol.

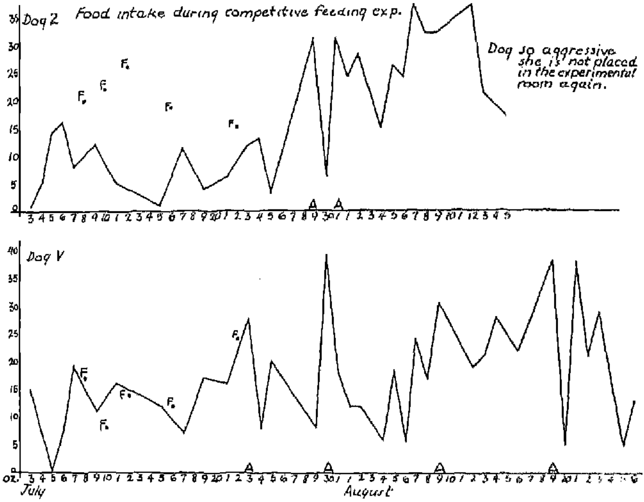


FIGURE 2
THIS FIGURE SHOWS THE FOOD INTAKE IN DOGS 2 AND 3
(All notations are the same as for Figure 1.)

were fed a number of times in separate pans in the kennel, with efforts made to protect the submissive animal. The amount of food consumed on these days is indicated by *F* on the graphs. It shows, in general, that at this time *V* and 3 were getting just about what they would eat in the kennels, while *R* and 2 were eating less than that amount. Of the two, Red was decidedly smaller, and had less appetite, but in any case, neither of these animals was eating as near their capacity as *V* and 3. Animal 2 dominated Red and could easily force him out of the food pan. This would seem to indicate that during July, Dogs *V* and 3 were dominant animals, and were getting most of the food.

D. SHIFT IN POSITION OF DOMINANCE

At the end of July, when the dogs were 119 days of age, the female, No. 2, suddenly shifted to the dominant position. This is definitely indicated by the rise in her food intake at this time. In general, this increase in food intake was made at the expense of Dog 3, since his record drops during this time. Dog Red had completely dropped out of the picture, getting no food at all except when he was given a dose of alcohol. By the middle of August, Animal 2 was so dominant and aggressive that she had to be removed from the experimental situation altogether in order to carry on the experiment.

To determine whether there is in fact any significant relationship between food intake and dominance, the mean food intake with the standard deviations were calculated for the whole period of July and August with critical ratios between the means. The averages and standard deviations are shown in Table 1. The mean is greatest for Animal 2, and least for Red, the submissive dog. The critical ratios between the means are presented in Table 2.

TABLE 1
THIS TABLE SHOWS THE MEAN AND *SD* OF FOOD INTAKE DURING THE COMPETITIVE FEEDING EXPERIMENTS

Dog	Mean food intake	*SD*	Mean: After alcohol	*SD*
R	5	3.7	18	5.9
V	16	8.4		
2	20	10.3		
3	11	7.8		

TABLE 2
THIS TABLE SHOWS THE CRITICAL RATIOS BETWEEN THE MEAN FOOD INTAKE OF THE DOGS

Between means	
Red and 2	9.3
Red and 3	3.8
Red and *V*	4.7
V and 2	1.94
V and 3	1.82
3 and 2	4

*The formula used in estimating the critical ratio, D/PE_D, was taken from: Garrett, *Statistics in Psychology and Education*, Longmans, 1941.

The most significant fact is the large critical ratio between Red and 2; those dogs showing the greatest difference in dominance, and that the critical ratio is smallest between *V* and 3, which seem to be about equal in dominance.

During the Winter in Georgia the dogs were checked in competitive feeding at intervals until maturity. The same dominance-submission was maintained as that appearing at 115 days of age.

E. DISPLACED AGGRESSION

One of the most interesting observations made during the experiments was the effect of conflict over food on members of the group. When conflict arose among the dominant animals of the group, it did not necessarily result in actual combat between them. In most cases this frustration was transferred to the submissive animal. This was especially noticeable in the case of Dog *V*. From July 11 to August 23, *V* attacked Red 26 times, in most cases while Red was far away from the pan in Zones 3 or 4. These attacks occurred when Nos. 2 or 3 forced *V* away from the pan. When attacked, Red would assume the passive defense attitude, lying on back with feet upward and yelling loudly, making no attempt to fight back. On one of these occasions it was necessary to pull *V* off Red since he was biting him severely but as a rule the experimenter interfered as little as possible in order to observe the developments of the reaction. Animal 2 attacked Red in this manner only five times, while No. 3 attacked No. 2 twice. There was every indication that the attack on Red acted as an emotional outlet following conflict and frustration over the pan.

There were not many actual fights between the dominant dogs during the feeding period, but there were many instances of frustration. The greatest conflict would occur after the lid of the food box was opened, and while each of the three dominant dogs was trying to put his nose in the pan. At times they would all keep their noses in the opening and growl, until finally one would force himself in and begin eating. As a rule when a dog got his nose in the pan, the others made less protest. After such defeat *V* would run over and attack the timid dog.

Dog *V* attacked No. 2 only once, and gave No. 3 a severe beating on one occasion. Animal 2 attacked *V* four times. It was observed in this experiment, as in the previous studies, that dominance is recognized in most cases without actual conflict. For example, when Animal 2 reached her dominant position at 119 days of age, it was done without much actual fighting behavior. All this animal had to do to hold the pan, or to force the others out after this time, was to growl vigorously.

F. THE EFFECT OF ALCOHOL ON THE SUBMISSIVE DOG

The attitude regarding this dominance-submissive difference is considered by the majority of investigators to be based on constitutional factors. It has been shown by Allee (1) and associates, for example, that the position of dominance may be changed in chickens by the injection of testosterone propionate. Beeman (2) has also shown that testosterone propionate will elicit aggressive behavior in castrate mice. These studies suggest that the position taken by the animals in the group is dependent to some extent on the glandular constitution. In spite of this fact, however, the question may be raised regarding psychological factors. It may be possible that repeated attacks from the dominant dog, as in the case of Red in this experiment, has a psychological effect. This may develop a conditioned fear reaction in the submissive dog, which acts as an inhibitor in the presence of the attackers. This seems plausible since, as we have stated above; the conditioned salivary response is inhibited in the timid animals by the mere presence of one of the dominant members of the group.

If this is the case, and these inhibiting factors would be eliminated by a drug, we would expect to get a more aggressive behavior from the timid animal. This hypothesis was tried out on Red in this experiment. On nine occasions Red was given a dose of 15 per cent alcohol by stomach from 8 to 10 minutes before the competitive feeding experiments. As a rule the dosage was .55 cc. per kilo of weight. It can be observed from Figure 1 that on these days the food intake of Red increased. The mean food intake, as indicated by Table 1, increased from 5 to 18 ounces, with a smaller *SD*. There were not enough cases to give a high reliability between the means, the critical ratio between the two means was only .66, but in any case this is suggestive of the fact that when small doses of alcohol are given, which possibly removed the cerebral inhibition, the dog becomes more aggressive. This is indicated not only by the increased food intake, but also by the table showing the positions of Red during the eating periods on three of these days. Table 3 contrasts the various positions of Red on three days in which he had a dose of alcohol with three days in which he did not have alcohol. On those days on which alcohol was administered Red spent more time in the pan, and

TABLE 3

This table shows the zonal positions of Dogs *R*, *V*, and 3 on three days in which Red was normal and three days on which Red was under the influence of alcohol. Animal 2 had been removed from the experiments at this time. The positions were noted every 10 seconds during eating. The top table gives a summary of 228 separate positions in percentage for August 15, 19, 21. The bottom table gives the summary in percentage of 243 separate notations of positions of each animal on August 20, 22, and 25, after Red had been given alcohol.

Dog	Nose in pan	Trying to get in pan	Standing in Zone 1 near pan	In Zone 2 away from pan	In Zone 3 away from pan	In Zone 4 away from pan
R	1.8	2.2	54	18.4	14.4	9.29
V	52	20.1	13.6	5.3	7.1	1.9
3	15.8	13.6	28.2	14.4	23.6	3.9
			After Red has been given a dose of alcohol.			
R	16.9	5.7	22.6	13.2	35	6.6
V	22.6	14.8	41.6	5.3	15.9	.4
3	26.8	24.3	9.8	4.9	33.8	.4

in areas immediately around the pan. It is possible that this increase in aggressiveness is due entirely to increased appetite. There was some indication that whenever any of the dogs was given alcohol there was an increase in food intake. This will have to undergo further experimentation, before definite conclusions can be drawn.

G. THE EFFECT OF COMPETITION ON GROWTH

The animals used in these experiments were F 1 hybrids obtained by crossing a pure bred Dalmation and an English Setter. Since the puppies were F 1's, we would not expect to have any great variation in size. It was observed from the beginning, however, that Red was smaller than the other animals. Since this dog seemed to be in good health and received the same treatment as the others it was thought to be possible that the emotional disturbance produced in Red in the conflicting situation may have had something to do with his size. The animal was in a sense in a limited and fear producing environment. Since Red was constantly attacked by the other members of the litter on many occasions, even when not eating, it is possible that there was a constant emotional tension which may have affected his growth. This would be exceedingly difficult to prove, however.

When the animals were removed to Georgia special care was taken to see that Red obtained more food and lived in an environment involving less conflict. The animals were separated and placed in different kennels. Red was placed with No. 3, which had attacked him less than the others, and he was given a pan of his own. Furthermore, he was protected during feeding so that none of the other dogs could molest him. Under this treatment his general health and appearance changed. There was an immediate increase in weight and appearance, and in a general sense, an alertness. The greatest change was in weight. At the end of the experiment in August, the weights of the dogs in kilos were as follows: *F*, 10; Red, 7.1; No. 2, 12.2; No. 3, 9.4. While at this time none of the dogs was fat, it was quite evident that Red was thinner and emaciated. The dogs were kept under the above conditions from September of 1947 until April of 1948, and at the end of this time the weights were as follows: *F*, 21.7; Red, 21.2; No. 2, 22; and No. 3, 21. There is of course no proof here that the difference in weight was due to frustration and emotional conflict involved while the dogs were together. It is suggestive, however, and will be worthy of further study.

H. Discussion

There is indication in this experiment that the dominant-submissive difference appears very early in the life of a puppy. It had appeared in the puppies used in the present experiment by 85 days of age. This means that in order to get a true picture of the development of this phenomenon, behavior studies will have to begin at an early age, probably from the beginning of nursing. The dominance order which appears early in life does not necessarily remain the same after maturity, since in the present experiment there was a shift in dominance at 115 days of age. The dominance order after this date, however, remained the same after maturity.

The dominant-submissive behavior has been considered to be dependent on constitutional factors. The experiments with the use of acohol, however, suggest that psychological factors may play a part in aggressiveness of the submissive dog following small doses of alcohol. It is possible that under the influence of alcohol, an inhibition, produced by repeated attacks from the aggressive animals is removed, leading to a more extrovertive behavior. This may be due entirely to increased appetite, but in any case, such behavior was not observed when the animal seemed to be ravenously hungry on other days. This increase in aggressiveness under the influence of alcohol is a characteristic of many types in human behavior, and we may be dealing with the same factor in this experiment.

The behavior which seems to be more strikingly human was the transfer of action from one member of the group to another following conflict and frustration. This transfer occurred mainly to the weaker member of the group. In human behavior this form of transfer is observed in many instances. The behavior of the lynching mob, for example, or attacks on minority groups, are considered by sociologists to be a result of frustration and dissatisfaction on the part of the attackers. They are in a sense living under conditions of fear in which they are not able to make adequate adjustments, or maintain their position. Since they are unable to get at the source of their grievance, they attack some source nearer, as for example, the minority group, or any group which is weaker and which is present at the moment. This form of behavior was especially used by Hitler during the second world war. The German people were in a sense whipped into a rage by repeated propaganda playing up the alleged hindrances to the development of the German people, then after the emotions were in a sense set for action, it was shifted on the Jews in Germany, or on a smaller nation. There was definitely a transfer here of the emotional action from one thing to another. This form of behavior, as we have seen, is observed in the dogs, and the transfer was made on the weaker member of the group. This attack on the weak dog acted as an outlet of the enhanced emotional behavior, and following such attacks the animal would settle down and remain quiet until another conflict occurred over food.

This experiment suggests that the timid animal of the group had difficulty in getting enough to eat while the animals were together. The submissive dog was unable to compete and thus comes out on the short end of the food. There were indications that the size of this animal was effected due to this factor. It seems that this phenomenon should be observed more carefully in the handling of children. It is well known that many modifications occur in the eating behaviors among children. Although the children may not actually compete at the table for food, since parents as a rule supervise them at this time, there is no doubt that many emotional conflicts arise between children, and between children and parents, which effect eating habits. The avoidance of certain food, or the dislike for certain foods, may possibly be a result of conflict arising in the home and on the playground among the children. The eating situation acts as a behavioral contest in which such frustration and discontent can be brought to the attention of the parents, and in a sense get back at every one involved. This may not be the same as the behavior observed in the dogs in the present experiment, but may suggest that the eating habits may be modified by emotional tensions in the situations.

I. SUMMARY

1. This experiment on a litter of four puppies shows that in a competitive food taking situation a dominance-submissive difference had already developed at 85 days of age. At this time three dogs were about equal in dominance, and dominated the other animal which was extremely timid and submissive.
2. There was a shift in the order at 115 days of age, when the female of the group assumed the dominant position. At this time the timid dog retained his position, while the other two remained in what has been termed the mid-group.
3. The dominant dog gets the most food in competitive feeding, and is able to keep the others away from the pan by growling.
4. There are indications that the submissive dog does not get enough to eat if the dogs are kept together and if any competition is involved in getting food.
5. Since the timid dog increased greatly in weight and in general health

after he was removed from the group and protected during eating, it is suggested that the emotional disturbance and conflict produced while with the litter has a detrimental effect on the growth and development of the submissive dog.

6. There are some indications that a dose of .55 cc of alcohol per kilo causes the timid animal to become more aggressive. On those days on which alcohol was administered there was an increase in food intake and the animal remained in Zone 1, the area immediately around the pan, more on these than on the other days.

7. There is definitely a tendency for one animal of the group to attack the timid dog following conflict and frustration over the food pan. This tendency was noticed in all the dogs to some extent.

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BILATERALITY*

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A. WHAT BILATERALITY CONSISTS OF AT DIFFERENT AGES

Bilaterality is frequently discussed in the literature without due consideration of its many varied forms. We present here a summary of the changes in type of bilaterality which take place during the first 10 years of life as the child manipulates objects while seated before a table top in the developmental examination situation.[1] Seven basic cases were followed through the entire age range in the course of this study and additional cases at each age level varied in number from five to 38.

The main thread of the development of bilaterality appears to be as follows:

The very first contact and manipulation of objects (16 weeks) is usually unilateral, with the non-dominant hand, perhaps partly due to the rigidity of posture, which is often of a *t-n-r* nature. (In the tonic neck reflex posture one arm, usually the non-dominant, is flexed; the other arm, on the side toward which the head is turned, is extended.) But by 20 to 24 weeks, behavior is frequently bilateral, the dominant hand reaching the object first, the non-dominant later. At 24 weeks there also occurs the beginning of a two-stage transfer in which the right hand, then both hands, then the left hand alone holds an object.

At 28 to 32 weeks there occur several different kinds of bilateral behavior: When the non-dominant hand makes the initial grasp of an object, the dominant hand is held ready, and quickly comes in to grasp too, or to take part in a two-stage transfer. Or, there may be simultaneous bilateral grasp of an object, both hands contacting object at once. Or each hand may manipulate a separate object. Or finally, both may manipulate the same object but in a somewhat differential manner.

By 36 weeks there is less bilateral behavior and even transfer occurs in one stage, object being taken from one hand by the other without the intervention of bilateral holding.

From 40 to 60 weeks, behavior continues largely unilateral. There is little simultaneous bilateral approach and grasp, though the non-dominant hand

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[1] The present article constitutes a brief supplement to an earlier study (7).

may come in to grasp an object held in the dominant hand; or each may grasp a different object.

At 18 months there is a good deal of bilateral behavior. The earliest bilateral grasp and manipulation, at 20 to 32 weeks, gave the appearance of occurring because the two hands had not separated off from each other functionally. From 36 weeks through one year, behavior is much more unilateral; a separation and differentiation into an active and a passive hand seems to be working itself out. *But by 18 months we find both hands coming back together again in a voluntary simultaneous bilateral grasp by the two hands which are nevertheless capable of working quite independently.*

At two years there is less bilateral behavior and what there is is of two kinds: non-dominant hand may remain passive and just come in in a helping rôle; or in a difficult situation or with a large object there is truly bilateral manipulation and grasp. *Two trends seems to be developing simultaneously*: the passive hand is becoming more passive and taking on more of a subordinate role in unilateral behavior; but when behavior is bilateral the two hands are becoming more equal to each other, especially temporally, and grasp is simultaneous. Timing is important here and a definite but paradoxical change is occurring. In bilateral behavior the two hands are moving more simultaneously, but in unilateral behavior less so. In unilateral behavior when the description of behavior is "right or left hand," there is a definite temporal separation, right hand predominating in one part of the examination and left in another, rather than one working, with other held actively ready to take over, transfer, and then manipulate at once at approximately an equal level of skill as was the case earlier.

From 2½ to 4 years, though less so around three years, there occurs a rather strong period of bilaterality which takes one of three forms: (*a*) Simultaneous bilateral approach and manipulation. (*b*) Passive hand held ready to come in as a helping hand. In almost no case does passive hand remain down by the side. (*c*) Use of one hand in one part of examination and of the other at a later time in the examination.

From 4½ to 10 years there is very little bilateral behavior. Passive hand becomes increasingly passive. Seldom is there a bilateral attack on a single object though as with adults, large or complex objects may be manipulated differentially. This trend toward unilaterality is slightly interrupted at seven years when some children exhibit considerable left handedness and/or bilaterality.

It should be particularly noted that at the very earliest ages (24-32 weeks) even when behavior is considered to be unilateral, the two hands work in close conjunction with one another. Even when one manipulates alone, the other is held actively ready to take over, transfer, and then manipulate at once at about an equal level of skill. It is as if the two hands had not yet separated off from each other functionally. During the next year the two rôles (active and passive) are being established, and by 18 months during unilateral behavior one hand alone may manipulate for an appreciable period of time before the other takes over entirely. There is an increasingly longer temporal separation of the activity of the two hands. But by 18 months as already noted, when behavior *is* bilateral, it tends to be a simultaneous approach and grasp.

Bilateral behavior not only varies in type and degree from age to age, but in different children as well. A detailed discussion of such individual differences will not be included here, but the following types of bilaterality characteristically seen in different subjects after their laterality has been established may be noted: (*a*) Use of both hands often simultaneously and with nearly equal skill. (*b*) Less dominant hand coming in slowly and used in a less skillful manner. (*c*) Less dominant hand held constantly ready to come in and assist dominant. (*d*) One hand at a time used but both held ready, and frequent shift.

B. WHEN BILATERALITY OCCURS IN SUPINE AND SITTING

It appears, therefore, that definite periods of unilateral arm behavior tend to alternate with periods of bilateral behavior in the human infant and preschool child as he responds to stimulus objects while in the seated position, the outstanding periods of bilaterality in the first year of life occurring normatively at 24 weeks and at 32 weeks.

This alternation of bilateral and unilateral behavior tends to occur regardless of postural orientation. Figure 1 compares the alternating periods of unilateral and bilateral response to a stimulus object while the subject lies supine, with alternating periods of unilateral and bilateral behavior while this same child is in the seated position. Data for this graph were obtained under an unusually controlled and systematic experimental situation. The subject, *MH*, was photographed daily in the supine position as she responded, visually and manually, to three interlocked red, white, and blue celluloid stimulus rings 4 cm. in diameter suspended above her within easy reach (8). This same subject was also photographed in the sitting position under the extremely controlled conditions of the developmental examination (9) at monthly intervals.

Though this child was judged to be definitely right handed at all ages

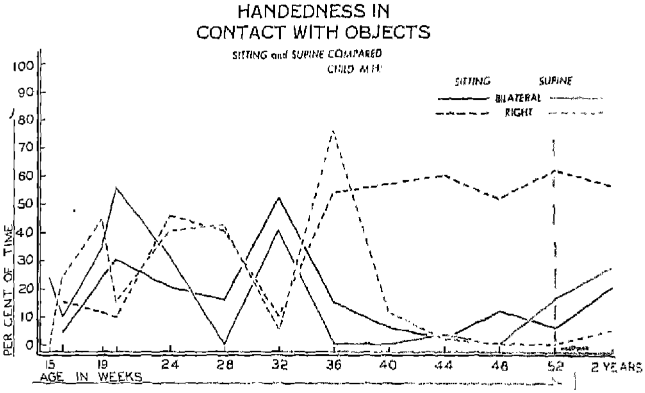

FIGURE 1

from two years through 10 years, the complexity of early handedness responses even in such a right-handed child can be clearly seen from the graph. As there indicated, the outstanding periods of bilateral behavior in both supine and sitting in this somewhat advanced child occurred at 19-22 weeks, and from 28-32 weeks.

The behavior of this illustrative though somewhat advanced child is not unique. Further study of the handedness of responses of other subjects while in the supine posture also indicates an alternation of periods of unilateral and bilateral behavior. An averaging of the time spent by six of our main cases in bilateral versus unilateral contact of the dangling ring as they lay supine in the normative examination situation reveals an alternation of bilateral and unilateral behaviors similar to that seen in Subject *MH*. Table 1 indicates these periods and includes a characterization of the supine arm postures typical during the last 17 weeks of the fetal period[2] when, though bilateral behavior tends to predominate, unilateral behavior as expressed in the *t-n-r* posture does frequently occur.

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[2] Observations during the fetal period were made on fetal-infants aged 28-40 weeks (4).

TABLE 1

Table of Unilateral vs. Bilateral Arm Behavior in Supine

	Fetal Period
23-31 weeks:	Bilateral postures predominate
32 weeks:	*T-n-r* tends to be conspicuous (unilateral)
33-36 weeks:	Mostly bilateral
37-40 weeks:	Considerable *t-n-r* (unilateral)
	Postnatal Period
1 week:	Bilateral
4-16 weeks:	Early asymmetry
20-24 weeks:	Bilateral
28-31 weeks:	Unilateral
32-36 weeks:	Bilateral
40-52 weeks:	Unilateral

C. Periods of Bilaterality in Leg Behavior

That periods of bilaterality shall alternate with periods of unilaterality is evidently a basic pattern of growth and not merely a phenomenon which appears uniquely in arm behavior. Study of the leg posturing of the normal infant suggests that such alternation of bilateral and unilateral behaviors occurs in leg as well as in arm activity.

Charting of the leg postures of Subject *MH*, who was photographed daily in the supine position throughout the whole first year of life, shows clearly that a definite alternation of periods, often of several weeks' duration, of predominant bilateral behavior and of predominant unilateral behavior were characteristic. This phenomenon is described in more detail in an earlier study (8).

A more detailed study of leg behavior in supine (1) based on a larger number of subjects—from 13 to 42 cases at each monthly age level throughout the first year of life—also reveals this alternation of periods of unilateral and bilateral leg behavior.

Not only do periods of bilateral behavior alternate with periods of unilateral behavior as the child lies supine, but when he is in the prone posture as well; and, interestingly enough, periods of bilateral leg behavior in supine correspond with periods of bilateral leg behavior in prone. This correspondence points strongly to the conclusion that "the primary forces which configure the movements and stances of infant posture are intrinsic, endogenous" (5).

D. Summary

The complex phenomenon of bilaterality has in this study been investigated in considerable detail. There appear to be many different types and expressions of bilaterality. Most striking, perhaps, are the differences which occur in its structure from one age to another. These changes are here delineated. The two hands at the earliest ages work very closely together as though they had not seperated off from each other functionally. From 36 weeks through one year a separation and differentiation into an active and a passive hand seems to be working itself out. By 18 months the two hands again move together, but now in a voluntary simultaneous bilateral grasp by the two hands which are nevertheless capable of working quite independently. After two years of age, the passive hand seems to become more passive and to take on more the subordinate rôle in unilateral behavior,—but in bilateral behavior the two hands are becoming more equal to each other, at least temporally, and grasp is simultaneous. But, increasingly, though the two hands may work together at the same time, they tend to manipulate objects differentially.

Bilateral behavior, though occurring to some extent at nearly all ages, tends to occur outstandingly in the normal infant and child at certain definite age periods. That these periods of bilaterality occur as a result of developing inner forces is suggested by the fact that the patterned alternation of periods of bilateral and unilateral manual responses seems to be characteristic of all subjects studied; by the fact that these periods occur regardless of postural orientation (that is whether the child is seated or supine); and by the fact that they occur in leg as well as in arm behavior.

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GROWTH AND DEVELOPMENT OF PSYCHOLOGY AT THE UNIVERSITY OF GEORGIA*[1]

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Psychology is 50 years old at The University of Georgia.[2] In the beginning of the school-term 1897-98, William Ellison Boggs, D.D., L.L.D., the Chancellor of the University and the Head of the School of Metaphysics and Ethics, taught two courses which were named Psychology. The Elementary Psychology was offered to Junior class students; Advanced Psychology was taken by Senior class students. Only students registered for the A.B. degree were admitted to these courses.

From 1897-98 to 1947-48 the story of Psychology is a narrative of beginnings. It is one of growth, of struggle, of expansion, of acceptance among the older sciences. This story is of interest to all historians of Psychology because it describes the progress of this discipline in a state supported institution which has the unique distinction of being the oldest chartered state institution in the U. S. A. It is well, therefore, to begin this history from the ancestral courses of pre-behaviorism and follow it to the present-day relationships.

Although the University of Georgia was chartered January 27, 1785, the earliest catalog among the archives is dated 1834. In that year the Reverend Samuel P. Presley taught a course in Mental Philosophy to Senior A.B. students. The topics discussed, the text used, the order of lectures given are not stated though Dr. Presley appears to have taught the course for four years.

In 1839, Alonzo Church, D.D., was named as the teacher of Mental Philosophy. As measured by the duties of today, this man must have had the strength and endurance of a giant. He was not only the teacher of Mental Philosophy but also the professor of Moral Philosophy, Political Economy, and International Law at the same time that he held the office of President of the University. Dr. Church appears to have continued all

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[1] Materials for this paper were compiled from the catalog of the University of Georgia, records, private papers, and interviews.

[2] As a separate subject, Psychology at the University of Georgia is 50 years old. As a part of Moral and Mental Philosophy, it may be said to have had its beginning in November of 1800 with the first curriculum approved by the Board of Trustees.

of these activities for 21 years, omitting only one year of teaching which was done by Dr. Stevens.

Under the leadership of Dr. Church, Mental Philosophy developed many identifying features. The catalog states that Brown's *Mental Philosophy* was used as the text and that Senior A.B. students learned "the analysis of external affection of the mind, sensations, coexistence of the sensations, and their coördinations with the emotions, laws of suggestion, analysis of conception, memory, the process of reasoning and of the emotions."

In the beginning of the session of 1839-40, Dr. Church changed the text used from Brown's to Upshaw's *Mental Philosophy*. This book remained in use until 1780, a period of 30 years. Apparently the topics of the class lectures did not change but a laboratory was added to the department which contained "complete Philosophical and chemical apparatus with which the professor is enabled to give illustrations of all important subjects in Experimental Philosophy." This laboratory was mentioned as a part of the instruction in Mental Philosophy until 1868-69.

Patrick H. Mell, D.D., was made Vice-Chancellor and Professor of Mental Philosophy in 1861. At this time the only change noted was that Junior as well as Senior A.B. degree students were admitted to the classes. During the next 10 years (1870-71 to 1881) Mental Philosophy increased in stature. It included lectures to Seniors on "Sensibilities and the Will" and to Juniors on "the intellect." The course was offered to A.B. students and was a course in the School of Metaphysics and Ethics. This school was housed in Franklin College and was taught by Dr. Mell who by this time had been promoted to be Chancellor and had acquired the honorary L.L.D. degree. No changes were made in the texts used or in the topics selected for instruction in Mental Philosophy from 1881-1887. A group of students registered for the degree of B.Ph., however, were admitted with the A.B. students.

Dr. Mell passed away on January 26, 1888, and Mr. A. A. Lipscomb was appointed to continue the teaching. He served for only one year.

William Ellison Boggs, D.D., L.L.D., was named Chancellor of the University of Georgia in 1888-89, and Professor of the School of Metaphysics and Ethics. He taught Mental Philosophy, using Sir William Hamilton's *Mental Philosophy* as a text. This was the last time this course was given by the name of Mental Philosophy.

The session of 1890-91 witnessed many changes in the school of Metaphysics and Ethics. Mental Philosophy was divided into Mental and Moral Philosophy and was called Mental Science. Porter's *Elements of Mental Science* was the text. The Juniors completed the text "to Part IV." At this point, they began the study of Logic. The Seniors, however, were required to complete "the more difficult part of Mental Philosophy by the study of Intuitions—Porter's Elements Part IV."

Chancellor Boggs continued the teaching of Mental Science as given in the outline above until 1897-98 when the Mental Science course in the School of Metaphysics and Ethics was replaced by a course called Psychology. Two courses in this subject were given. For five months, with two exercises per week, the Junior A.B. students studied Elementary Psychology using Porter's *Elements of Mental Science* as a text. The topics included: consciousness, sense perception, memory, phantasy and imagination. The Senior A.B. students had three exercises per week for six months. They, too, used Porter's *Elements of Mental Science* to "discuss critically" such topics as: the intuition, space, time causality, final cause, substance and attribute, mind and matter, the finite and infinite." A graduate course using Porter's *The Human Mind* plus selections from Hamilton's and other philosophy texts was offered. Psychology for the first time in the University was required for the A.B. degree, to be taken in both the Junior and Senior classes.

Professor Walter B. Hill, M.A., B.L., and later L.L.D. (1899-1900) became Chancellor and new Head of the School of Metaphysics and Ethics. During his administration, "arrangements were made with the Board of Education for special lectures." Under this arrangement, Professor E. C. Branson (1900-01) taught the Psychology courses. The following changes were made: William James, *Psychology, Briefer course* was used as a text; no advanced courses were offered and Junior students only were required to take the subject. Also, under the arrangement for special lectures, Mr. G. G. Bond (1902-1903) taught Psychology. No change was made in the text used. Juniors only were required to take the course, but Titchener's *Experimental Psychology* "a laboratory course with apparatus" was given. Apparently, the latter course was made more effectual by a gift (1902) from the Honorable Oscar Strauss of a "psychological laboratory for experimental teaching."

Thomas Jackson Woofter, A.B., M.A., Ph.D., in 1904 became head of the former school of Metaphysics and Ethics, now changed to the Department of Philosophy and Education. Under his direction several changes were made. Introductory Psychology and General Psychology were the names used instead of Elementary Psychology, and three texts were used for the course—Baldwin, Witmer, and Titchener's *Primer of Psychology*. Educational Psychology was added which required Introductory Psychology as a prerequisite. These courses were required at first, but later they were optional for Juniors and Seniors.

Both good and bad fortune atended the development of Psychology during the year 1904. By good fortune Judge Horace Russell of New York City endowed an annual prize of $50.00 for the best essay written on a subject assigned by the Professor of Psychology. The bad fortune came when the Science Hall was burned and the psychological laboratory was completely destroyed. However, by 1905-06, this laboratory was restored and was "partially equipped." A notation in a later catalog, 1907-08, states: "The Psychological Laboratory is gradually being equipped. A considerable supply of modern apparatus is now on hand to illustrate the course in General Psychology with all necessary experiments. It is the intention of the University to develop this laboratory rapidly into one of the best for modern experiment and research."

Throughout the years the teachers of Psychology at the University of Georgia appear to have been of the highest order. Most of them remained to serve for more than one session. However, in 1906, there are the shadows of great Georgians who paused for a brief service during the summer sessions and passed on to achieve distinction in widening circles. Among the better known were: Dr. Jere M. Pound, (1906-07) who taught Elementary Psychology and Psychology Applied to Education for the summer sessions. He later became State Superintendent of Education and a few years later President of the Georgia State Teachers College and the Georgia Woman's College. Dr. William Heard Kilpatrick, (1906) who was a professor and Vice-President of Mercer University, taught during the same summer session as did Dr. Pound. His courses were Educational Psychology and Theory. Dr. Kilpatrick has had a long and distinguished career as Professor of the Philosophy of Education at Teachers College, Columbia University, New York. Because of his books, lectures, and papers on the art and science of teaching, his reputation is world-wide. Miss Celeste Parrish was a teacher of many and varied distinctions. For several summer sessions she taught Child Psychology at the University of Georgia by the experimental and observational methods. As Head of the Department of Pedagogy at the State Normal School in Athens, Georgia, she was recognized for important advances. Among the better remembered are: She directed the student teachers in the Muscogee Training School in developing unique projects and advanced techniques, finally writing a book on Methods in order to clarify her instruction. By the aid of a gift from the Honorable George Peabody, she established a well equipped laboratory, 1902, at the Normal School for the study of experimental procedures in General Psychology, using the methods of Titchener. She also served in the State Department of Education, Atlanta, Georgia, and was the inspiration for the organization of the first Parent-Teachers Association.

The following 10 years, 1907-17, presented a period of expansion both in additional courses and in laboratory facilities. The new courses added were Social Psychology, Psychology of Development, which included an introduction to Comparative and Genetic Psychology, Mental States and Deficiency. Mr. Harwell B. Peacock joined the staff as a tutor, and Professor Ludwig R. Geisler was asked to develop advanced courses in Experimental Psychology, Systematic Psychology, and to direct the equipment of a laboratory described as having "eight rooms on the first floor of Peabody Hall equipped with the latest instruments for studies of senses, feeling, attention, memory, etc. Every room is brought into connection with every other room by a system of electric wiring. All rooms supplied with electric current, and gas, and most rooms have city water and sinks. One room used for photographic dark room, two others devoted to research work." Dr. Geisler used the method of Introspection and Simple Experiment. Advanced Psychology was taught by Problems in which the laboratory and many texts were consulted. Titchener's *Laboratory Manual* was the guide for the laboratory work. The course was taught to both A.B. and B.S. students.

During the four World War years 1916-20 there were definite changes. Abnormal Psychology, Psychology of Exceptional Mental States were added to the already extensive curriculum. Dr. C. S. Heatwole taught Social Psychology and Psychology of Business Procedures, and Dr. Joseph S. Stewart taught Legal Psychology and Vocational Psychology. But the most definite change was in the student body: Peabody School of Education was opened to Women.

The most profound and effectual change in Psychology came in 1921-23 when the faculty of the University voted Psychology the right to be "free and independent" of all other departments. Psychology in its early beginnings was Mental Philosophy, appearing as a twin of Moral Philosophy and remaining by her side for 70 years. In 1904, she became an aid to and an assistant of the Department of Education, remaining in this service for 17 years. But the great day came in 1921-22 when Psychology was made an independent department and separated from the Peabody School of Education, to become an integral part of the College of Liberal Arts and Sciences with the freedom to develop a content and a curriculum peculiar to its own discipline.

Austin Southwick Edwards, B.S., M.A., Ph.D., who had joined the Peabody School of Education staff in 1916, but who had been called into government service in 1917 to become a captain in the army for the duration of World War I, returned to the classroom at the University of Georgia and was made the head of the new department. He at once advocated this policy: Psychology would be both an independent and a service department. On the one hand, theory and experiment would grow together; laboratories would be equipped for the expansion of experimental work and for the furtherance of research. On the other hand, there would be no curtailment of services to any other departments, not only in the School of Liberal Arts and Sciences but in the schools and departments of all areas of the University.

The new department was housed in the Academic Building and there began a growth and development commensurate with the extended opportunities. Tests and Measurements and Mental Hygiene were courses added to those already in the curriculum. Psychology 5 was developed as a beginning course in Experimental Psychology. A laboratory was equipped gradually with the newest instruments suitable for the study of psychological techniques. Titchener's *Textbook in Psychology* was used for class instruction and Titchener's *Manual* was used as a laboratory guide. No freshmen were allowed to register for these courses. For the first time, a laboratory fee was charged.

Dr. Edwards was assisted in teaching and in laboratory instruction by graduate students who were candidates for the Master's degree in Psychology. These students assisted in promoting the growth of the department and witnessed evidences of expansion. Mr. James R. Patrick was the first assistant. He helped with the beginning organization. When he left for advanced study, Miss Willie Mae Cook became assistant. In 1929 she saw the Department of Psychology become a charter member of the National Honorary Fraternity, Psi Chi. When Miss Cook went for further study, Thomas Williard Harrell became instructor. He assisted in probably the most important expansion: the establishment of the University of Georgia Clinic. Dr. Edwards was made Director of this service which included not only the students of the University but also the pupils of the Athens City Schools. The approval for this clinic reads:

> The work was expanded to include studies not only psychological and physical but also psychiatric and neurological. Relationships have been built up with the State Hospital in Milledgeville, Georgia, through Dr. R. C. Swint. A representative of that institution, Dr. George L. Echols, was appointed to act as Psychiatrist for the clinic and to visit the University for two days each month for this purpose. Coöperative relationships also have been made with Superintendent B. M. Greer of the

> Athens Public School, with E. A. Lowe of the Personnel Office, with the Dean of the student body, and with Dr. Harold Reynolds, University physician. Graduate and advanced students may be allowed to work in the clinic.

The catalog of 1930-1931 makes this notation: "The clinic thus far has been obliged to limit the activities on account of a lack of staff and facilities for work." This condition was somewhat relieved as to staff shortage when the University began a reorganization program which united all of the State supported institutions located in Athens. The Psychology Departments at the College of Agriculture and at the Georgia State Teachers College were added to that of the University. Dr. Edwards was the Director and Florene M. Young, A.B., M.A., Ph.D., and May Zeigler, A.B., M.A., joined his staff. This increased staff enabled the clinic to expand its services to the extent that in 1935 it was called upon to assist the Personnel and Placement Bureau, directed by Mrs. Mary Claire Bondurant, in giving more direct and vital help to the students both in personnel and clinical services.

The Psychology Department in 1933-34, was enlarged with the reorganization of the University. To meet the new growth it was necessary to expand the physical plant. From one office and classroom-laboratory in the Academic Building, the department was moved to the Strahan House, where it remained for two years. The quarters were again too limited for needed growth and expansion so the Department was given Meigs Hall. In this building there are two large lecture rooms, four laboratories (beginning experimental, advanced experimental, psychometrics, and animal), rooms for seminars, consultation, individual research problems, photographic dark room, and individual offices for teachers, secretaries, and graduate students as well as quarters for the janitors in charge of the building.

Curricular changes increased to meet the new demands. The reorganization divided the classes into divisions, 1933-35, and combined the departments into unit groups. Under the program Psychology I was a junior division course while Social, Genetic, Applied, Clinical, Abnormal, and Special Problems were senior division courses. Systematic, Advanced Experimental, and Clinical Psychology were given both as undergraduate and graduate courses. Psychology was offered as elective courses and was open to all students except entering Freshmen. In the unit grouping of departments, the Psychology Department was made a member of the Biology Science Division.

At this time combination service courses with increased laboratory facilities were added. The first new laboratory service was opened for student use when President S. V. Sanford, in conference with Dr. Edwards, appointed Dr. Florene M. Young to be Professor of Developmental Psychology and Consultant Psychologist for the Nursery School. This school had been established in 1929 by Dr. Andrew Soule, the former President of the College of Agriculture, and had been developed under the direction of Professor Mary E. Creswell, Head of the Department of Home Economics. Another new laboratory was opened when Robert Travis Osborne, B.S., M.S., a member of the Veterans Guidance staff, joined the Psychology faculty and was assigned the development of the psychometric laboratory. He was later made the Director of the Veterans Guidance Center, which has its offices in Baldwin Hall. The Center has a trained staff and employs a visiting Psychiatrist for one day per month. The Psychometric laboratory and the Guidance Center combined with the University of Georgia Clinic offers neurological, personnel, and psychiatric services not only to veterans but to all Georgia students.

There is one expansion more personally prideful that the department boasts. Dr. Edwards succeeded in building an instrument called the Finger Tremometer which measures involuntary finger tremor. This instrument has been used to investigate many related problems for research.

The extension of the laboratory services and the urgent problems needing study made it necessary to increase the staff. Dr. W. T. James, B.S., Ph.D., was appointed in 1945-46 to give courses in Comparative and Physiological Psychology and to develop an animal physiological laboratory suitable for the exploration of physiological problems as they affect psychological factors in behavior. Opportunities for psychological service courses were suggested by the Department of Business Administration. Dr. J. Stanley Gray, Ph.D., in 1947 came from the University of Denver to teach such allied courses and develop a laboratory which would allow the study of such problems as are pertinent to Business and Industrial relationships.

Here the story ends. The growth is one of solidity and symmetry except for two deviations which are unique at the University of Georgia. First, Psychology is regarded at this University as both a biological and as a social science. Credit is given by each of these two divisions for such courses as are related to their curricula. Second, there are courses which are usually given in a Department of Psychology that are listed in the Department of Education. This is peculiar to the curriculum at the University of Georgia and apparently came about for this reason: the State Department of Education in Atlanta, Georgia, planned to improve the teaching level in the state by accrediting certain courses which appeared pertinent to the teacher's needs.

It was decided that the application of Psychology to the principles of education and such related courses should be taught in the Department of Education. Therefore, members of the staff of the Peabody School of Education teach those accrediting courses to teachers who register at the University of Georgia.

As the Faculty of the oldest chartered State University looks back over 50 years, there are milestones which may be counted: Growth in courses given and in the number of teachers employed for every decade; the struggle through four periods when war beat about the doors and disrupted the functions; the expansion from a single course to many courses and services, and finally the acceptance by the Biological Sciences. The small beginning in a past, more than 100 years ago, was of a firm and spreading rootage. This growth has come down to the present deep and rich and strong and carries no hint either of decadence or of termination. From the side of Moral Philosophy in the family of Metaphysics to a helpful service in the cause of Education, Psychology has come in this University to build its own habitation, to write its name upon the records, to extend its service to fellow departments, and to institute its own research contributions for the increased knowledge of mankind.

The teachers of Psychology in the past years appear to have been chosen for their scholarship and building ability. The policy today is not different. It is one with all of the departments in the College of Liberal Arts and Sciences. Emphasis is placed upon abilities basic for University functions as set forth in the charter: "Et docere et rerum exquirere causas" which interpreted in the language of 1948 is: To teach, to write, to pursue research. Verily it was so for Psychology in the beginning; it is now, and hopes are brave that it ever shall be.

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A STUDY OF HUMAN LOVE RELATIONSHIPS*

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The present paper is the fourth of a series reporting several "pilot studies" on love and family attitudes and behavior (1, 2, 3). It deals with a questionnaire study of 500 college girls in 19 widely scattered American colleges. The questionnaire was administered anonymously to the subjects by their instructors, who encouraged the girls to take them home, to be filled out at their leisure. The schedules were then to be mailed directly to the author, with whom the subjects had no contact or acquaintance. About 80 per cent of the questionnaires distributed were actually filled in and returned to the author.

A. BACKGROUND DATA ON THE SUBJECTS

The subjects of this study were between 18 and 29 years of age, the median subject being 20. They were almost equally distributed among the four years of college. All were white and all were American citizens. Sixty-nine per cent were Protestant; 20 per cent were Catholic; and 11 per cent were Jewish. Seventy-three per cent had parents who were both born in the United States; 27 per cent had one or both parents who were foreign born. Sixty-eight per cent of the girls were single, 29 per cent were engaged, and 3 per cent were married.

The median girl studied graduated from grade school at the age of 13. Her father and mother both were high school graduates. Her family's yearly income was $4,000 a year. Her family possessed both a car and a telephone.

Forty-three per cent of the girls had permanent residences in the East, 10 per cent in the South, 22 per cent in the Midwest, and 25 per cent in the West. Eighty-two per cent of the girls attended a public grade school, 7 per cent attended a private school, and 11 per cent attended a parochial school. Ninety-two per cent of the subjects attended a coeducational high school, and eight per cent attended an all-girl high school. Ninety-one per cent attended a coeducational college; and nine per cent attended an all-girl college. Thirty-one per cent of the subjects were raised in communties of less than 5,000 in-

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habitants; 46 per cent were raised in fairly sizeable cities; and 23 per cent were raised in very large cities.

Seventy-six per cent of the girls came from homes where their parents were still living together; 12 per cent came from homes broken by divorce or separation and 12 per cent from homes broken by the death of one or more parents. Forty-eight per cent of the subjects had no brothers, 38 per cent had one brother, 14 per cent had two or more brothers. Forty-two per cent had no sisters, 34 per cent had one sister, and 24 per cent had two or more sisters. Forty-four per cent of the girls stated that they attended church regularly; 37 per cent said that they attended now and then; and 18 per cent said that they never attended.

In general, the background data given by the respondents showed that they seem to have made a sincere attempt to answer the questions frankly and honestly; and that they seem to have been fairly representative of American college girls, though not of all American girls.

B. The Findings

Part I of the questionnaire which was given to the 500 subjects of this study consisted of 18 factual questions on their past and present love histories. These were uncategorized questions, with blank spaces left for the subjects to fill in the proper answer. Thus, the first question was: "The very first time I became infatuated with a man or boy was when I was .... years old." The final question was: "Not counting my close relatives, I am now very fond of .... women or girls."

The subjects' responses to Part I of the questionnaire are listed and discussed below.

1. *Age at First Infatuation or Love Attachment*

The median girl in this study first became infatuated with a male when she was 12 years old and first fell in love when she was 17 years old. The complete distributions of the girls' infatuations and loves are shown in Table 1.

Several points may be noted from an examination of the data in Table 1: (*a*) While infatuations were frequent during prepuberal years, love attachments surged remarkably just after the onset of normal puberty. (*b*) The peak for infatuations occurred during the 11th and 12th years; while that for love attachments occurred during the 17th and 18th years. (*c*) An additional check showed that all the subjects, at the time of responding, had experienced at least one infatuation *or* love attachment for a male; although,

TABLE 1
PERCENTAGE OF FIVE HUNDRED COLLEGE GIRLS FIRST BECOMING INFATUATED AND FALLING IN LOVE AT STIPULATED AGES

Age	Percentage of subjects first becoming infatuated	Percentage of subjects first falling in love
4-6	6	1
7-8	10	2
9-10	24	2
11-12	16	2
13-14	15	14
15-16	11	19
17-18	8	25
19 or over	2	21
Never	8	14
Total	100	100

as indicated in Table 1, eight per cent of those having a love attachment admitted having no infatuations, while 14 per cent of those having infatuations admitted having no love attachments.

2. *Number of Early Infatuations and Loves*

The median girl studied stated that she had one infatuation and no love attachments before her 12th year. The distributions of the subjects' early infatuations and loves are shown in Table 2.

TABLE 2
PERCENTAGE OF FIVE HUNDRED COLLEGE GIRLS HAVING A STIPULATED NUMBER OF INFATUATIONS AND LOVES BEFORE THE AGE OF TWELVE

Number of infatuations or loves	Percentage of subjects having infatuations	Percentage of subjects having love attachments
0	43	89
1-2	26	6
3-4	15	2
5-6	8	1
7 or more	8	2
Total	100	100

There is a slight discrepancy between the facts shown in Table 2 and those shown in Table 1. According to Table 2, 57 per cent of the girls had at least one infatuation and 11 per cent at least one love attachment before the age of 12; while, according to Table 1, 56 per cent of the girls had infatuations and 7 per cent had love attachments before the age of 13. Apparently, asking a subject how *many* infatuations or loves she had at a certain time made her more apt to recall them than asking her *if* she had any. Kinsey, Pomeroy, and Martin (5) make a similar observation.

In other respects, both sets of distributions indicate that the subjects had a greater propensity for becoming infatuated than for falling in love during their prepuberal years.

3. *Number of Infatuations and Loves Between Twelve and Eighteen*

The median girl studied became infatuated five different times between her 12th and 18th years, but only fell in love once during this period. The distributions of the adolescent girls' infatuations and loves are shown in Table 3.

TABLE 3
PERCENTAGE OF FIVE HUNDRED COLLEGE GIRLS HAVING A STIPULATED NUMBER OF INFATUATIONS AND LOVES BETWEEN THE AGES OF TWELVE AND EIGHTEEN

Number of infatuations or loves	Percentage of subjects having infatuations	Percentage of subjects having love attachments
0	16	31
1-2	14	47
3-4	20	10
5-6	23	5
7 or more	27	7
Total	100	100

Examination of the data in Table 3 again shows that the girls had many more infatuations than love attachments. However, it appears that a considerable minority of the girls, in addition to having multiple infatuations during their adolescence, also were rather promiscuous in their love attachments. Thus, some 22 per cent of the subjects admitted being in love three or more times between their 12th and 18th years.

4. *Number of Infatuations and Loves After Eighteen*

The median subject of this study, although only 20 at the time of responding to the questionnaire, admitted having one infatuation and one love attachment since her 18th year (in addition to those already recorded for the earlier periods of her life). The distributions of the girls' adult loves and infatuations are shown in Table 4.

The significant fact to be noted from analysis of Table 4 is that although more of the girls apparently fell in love than became infatuated with males after their 18th year, those who fell in love in their adult years tended to do so only once or twice, while those who became infatuated after 18 tended to

TABLE 4
PERCENTAGE OF FIVE HUNDRED COLLEGE GIRLS HAVING A STIPULATED NUMBER OF INFATUATIONS AND LOVES SINCE THE AGE OF EIGHTEEN

Number of infatuations or loves	Percentage of subjects having infatuations	Percentage of subjects having love attachments
0	34	27
1-2	26	58
3-4	17	10
5-6	12	4
7 or more	11	1
Total	100	100

do so three or more times. It may also be noted that, since 40 per cent of the subjects admitted three or more infatuations and 15 per cent of *the very same* girls admitted three or more loves since their 18th year, considerable amative promiscuity seems in evidence in their affectional histories.

5. *Time Elapsed Between Consecutive Infatuations and Loves*

The median girl studied took about four weeks to become infatuated again with a male after one of her infatuations had ended; and took about 16 weeks to fall in love again after one of her love attachments had ended. The complete distributions showing the time elapsed between consecutive infatuations and loves are shown in Table 5.

According to the data of Table 5, the girls were apparently able to become infatuated with a male shortly after their last infatuation had ended; but —if their stories are to be believed—they took considerably longer to fall in love again after one of their love attachments had ended.

TABLE 5
PERCENTAGE OF FIVE HUNDRED COLLEGE GIRLS TAKING A STIPULATED AMOUNT OF TIME TO BECOME INFATUATED OR FALL IN LOVE AGAIN AFTER ONE ATTACHMENT HAD ENDED

Number of weeks subject usually took to become infatuated or fall in love again	Percentage of subjects who became infatuated again after one infatuation ended	Percentage of subjects who fell in love again after one love ended
Immediately	6	0
1-4	38	13
5-8	19	9
9-26	16	25
27 or more	7	18
Indefinite answer	14	35
Total	100	100

6. *Number of Simultaneous Infatuations and Loves*

The median subject of this study said that on one occasion she was infatuated with two males at the same time; but that she never was in love with two males simultaneously. The distributions of the girls' simultaneous loves and infatuations are shown in Table 6.

TABLE 6
PERCENTAGE OF FIVE HUNDRED COLLEGE GIRLS HAVING A STIPULATED NUMBER OF SIMULTANEOUS INFATUATIONS AND LOVES AT SOME TIME DURING THEIR LIVES

Number of times infatuated or in love with two males simultaneously	Percentage of subjects infatuated with two males simultaneously	Percentage of subjects in love with two males simultaneously
0	42	75
1-2	34	21
3-4	19	4
5 or more	5	0
Total	100	100

The data in Table 6 indicate that 58 per cent of the girls admitted being infatuated at least once in their lives with two men at a time; while 25 per cent admitted being in love at least once in their lives with two men at a time. When it is realized that the girls admitting the simultaneous infatuations and loves were the *same* 500 subjects of the study; that they were only about 20 years old at the time of answering the questionnaire; and that their admissions of plural attachments may probably be taken as a *minimal* estimate of the true occurrence of these attachments among them, it is clear that the existence of simultaneous and/or love at some time during their lives tended to be the rule rather than the exception with the subjects studied.

7. *Duration of Infatuations and Loves*

The median girl studied reported that after she became infatuated with a male she usually remained infatuated with him for about six weeks; and that after she fell in love with a male she usually remained in love with him for about 36 weeks. The distribution of the subjects, responses in regard to the duration of their infatuations and loves is shown in Table 7.

If the responses tabulated in Table 7 mirror the true length of the subjects' infatuations and loves, it is obvious that the girls remained in love decidedly longer than they remained infatuated with a male. However, since only 3 per cent of the girls would definitely state that their infatuations usually lasted for more than a year, and only 24 per cent would definitely

TABLE 7
PERCENTAGE OF FIVE HUNDRED COLLEGE GIRLS REMAINING INFATUATED OR IN LOVE WITH A MALE FOR A STIPULATED NUMBER OF WEEKS

Number of weeks subject usually remained infatuated or in love with a male	Percentage of subjects remaining infatuated	Percentage of subjects remaining in love
1-4	29	5
5-8	20	5
9-26	21	14
27-52	4	19
53 or more	3	24
Indefinite answer	23	33
Total	100	100

state that their loves usually lasted for more than a year, it appears that the subjects as a whole hardly displayed any considerable degree of amative fidelity.

8. *Current Infatuations and Loves*

The median girl, at the time of answering the questionnaire, reported that she was infatuated with no males and in love with one. The distributions of the girls' current infatuations and loves are shown in Table 8.

TABLE 8
PERCENTAGE OF FIVE HUNDRED COLLEGE GIRLS CURRENTLY INFATUATED OR IN LOVE WITH A STIPULATED NUMBER OF MALES

Number of males subjects were infatuated or in love with at the time of responding to the questionnaire	Percentage of subjects infatuated with a male	Percentage of subjects in love with a male
0	69	29
1	14	65
2-3	13	6
4 or more	4	0
Total	100	100

From Table 8 it can be seen that although 71 per cent of the girls reported that they were in love at the time of answering the questionnaire, as against only 31 per cent reporting infatuations, only 6 per cent admitted current simultaneous loves, while 17 per cent admitted current simultaneous infatuations.

9. *Number of Close Friendships*

The median girl in this study said that she was, at the time of answering the questionnaire, very fond of four male friends and six female friends. The distributions of the subjects' close friendships is shown in Table 9.

TABLE 9
PERCENTAGE OF FIVE HUNDRED COLLEGE GIRLS REPORTING CLOSE FRIENDSHIPS WITH A STIPULATED NUMBER OF MALES AND FEMALES

Number of male or female friends subjects were very fond of at time of responding to the questionnaire	Percentage of subjects very fond of male friends	Percentage of subjects very fond of female friends
0	10	3
1-2	16	9
3-4	34	21
5-6	13	19
7 or more	27	48
Total	100	100

According to the responses listed in Table 9 the subjects reported decidedly more close attachments to female than to male friends. This seems quite in accord with common observation.

C. DISCUSSION

The major fact revealed by the foregoing findings is that the girls studied reported several differences between their infatuations and their love attachments. If their responses are considered to be true representations of their amative behavior, it would appear that (*a*) they tended to become infatuated earlier than they tended to fall in love; (*b*) they had more prepuberal infatuations than loves; (*c*) they had more adolescent infatuations than loves; (*d*) they had fewer single but more plural infatuations than loves from their 18th year onward; (*e*) they more quickly became re-infatuated than re-loving after a given involvement had ended; (*f*) they had more simultaneous infatuations than love attachments; (*g*) their infatuations were shorter than their loves; and (*h*) at the time of answering the questionnaire, they had more single loves than infatuations but more simultaneous infatuations than loves.

These findings consistently show that the subjects' reported infatuations were, in their preadolescent and adolescent years, briefer, lighter, and more promiscuous than their reported loves. In their more adult years, they tended to have fewer infatuations than loves; but those who did have infatuations experienced them on a more promiscuous basis than those having love attachments.

It is tempting to conclude from these findings that infatuations may be defined as amative involvements which, compared to love attachments, are relatively brief, light, and varietist. It must be remembered, however, that our society is one whose conventions and teachings encourage prolonged, intense, and monogamous loves (since these, presumably, may lead to more stable marriages) and whose mores discourage and disparage light, promiscuous love relations. Consequently, the subjects of this study may have, in a self-defensive or ego-protecting manner, unconsciously (or even consciously) thought of their lighter and briefer loves as *infatuations,* while reserving the term *love* for their stronger and more lasting involvements.

Some evidence to this effect may be seen in the tendency of the respondents to report that the majority of their *most recent* emotional involvements were *loves* rather than *infatuations.* It is to be wondered what percentage of these same contemporary *loves* would, several years hence, when they might have been replaced by subsequent amative attachments, *then* be viewed as *infatuations.* In other words, one interpretation of the observed data might be that girls in our society tend to view their *past* loves as infatuations and their *present* infatuations as loves. The differentiation between the two terms may be largely a relative one, whose base continually changes.

One conclusion which, no matter how the terms *infatuation* and *love* are differentiated, is clearly derivable from the observed data is that distinctly monogamous amative attachments were the exception rather than the rule among the group studied. Of the 500 subjects of the investigation, 7 per cent reported two or more loves before the age of 12; 34 per cent had plural loves between the ages of 12 and 18; and 32 per cent reported more than one love after the age of 18. In addition, 25 per cent of the girls reported simultaneous loves at least once during their lives and 6 per cent said they were in love with two or more males simultaneously at the time of answering the questionnaire. As for consecutive and simultaneous infatuations, the figures were in all cases considerably higher than those for consecutive and simultaneous loves.

When it is remembered that these are probably minimal figures, and that they are obtained from girls who were still very young at the time of responding, and many of whom presumably will have additional infatuations and loves as they grow older, it can readily be seen that the monogamic ideal of a girl's falling in love and remaining in love with one man during her entire lifetime is being scouted by the vast majority of these subjects. Even the monogynous ideal of love—namely, that a person should become amorously attached to members of the other sex on a one-at-a-time (instead of the strictly monogamous once-for-a-lifetime) basis—is by no means being rigidly adhered to by the subjects, since a sizeable minority admitted having simultaneous attachments at some time during their lives.

It may be noted that the facts of the present study are in agreement with the findings of Hamilton (4) who, interviewing a group of 100 adult males and 100 adult females found that his subjects reported having about seven love affairs apiece up to the time of being interviewed.

Since the present (1947-8) questionnaire investigation of college girls substantially agrees with Hamilton's (1927-8) interview study in revealing considerable amative varietism on the part of female subjects, it is to be questioned whether societal teachings which emphasize the desirability of monogamic, or even monogynic, love involvements abet the mental well-being of the majority, or at least a sizeable minority, of humans who seem unable to conform to this pattern of living and loving. For when a girl has been taught—at home, in school, in Sunday School, and through book, radio, and motion picture appeals—that she is supposed to have few or no infatuations and only one real, lifetime-lasting love; and when this same girl finds that, before she has even graduated from college, she already has had several infatuations and/or loves, it is to be doubted that she will experience her successive, and especially her possible simultaneous, amative involvements without decided (conscious or unconscious) feelings of anxiety, guilt, and self-depreciation. The wisdom of society's teaching this girl that she should follow a pattern of amativeness which, as indicated by the data of this and Hamilton's studies, it seems most likely that she will *not* in fact follow, is definitely to be questioned.

D. SUMMARY

Five hundred college girls, who apparently constituted an adequate cross-sectional sample of American college subjects, were given a questionnaire on their love and family attitudes and behavior. An analysis of their responses to Part I of this questionnaire reveals that the girls reported becoming infatuated on a briefer, less intense, and more varietist basis than they reported falling in love. In regard to both their infatuations and their love attachments, the subjects admitted a considerable number of consecutive and simultaneous involvements which belie some of the monogamous and monogynous amative teachings of our society. Twenty-five per cent of the girls, for example, admitted being simultaneously in love with two or more males at least once in their lives; and 58 per cent of the very same girls admitted at least one simultaneous infatuation. In view of this observed high degree of amative varietism, the wisdom, from a mental hygiene standpoint, of society's insisting on monogamic love standards for all persons is questioned.

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AN EXPERIMENTAL STUDY OF EASEL PAINTING AS A PROJECTIVE TECHNIQUE WITH NURSERY SCHOOL CHILDREN*[1]

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A. THE PROBLEM AND PROCEDURE

The study here described is confined to an investigation of easel painting as a projective technique for use with nursery school children. The purpose was to discover what behavior traits were reflected in the easel painting products. Alschuler and Hattwick's experiment has been used as a basis for the painting analyses. In their experiment, 149 children from eight nursery schools were studied for one year. Twenty-one of these children were studied a second year. The children included all social classes; one group was Czechoslovakian, another, Negro, the remainder, white American. The ages of the children varied from two-and-one-half to five-and-one-half years old, predominately 3½ to 4½. Very complete daily records were kept on each child and the final analyses were based on all the information gathered about each child, not just the easel products. The record sheets used in the present experiment have been adapted from some of Alschuler and Hattwick's (1). In the final results of Alschuler and Hattwick's experiment, almost 50 different painting "styles" were found which definitely indicated traits of their producers. Alschuler and Hattwick found that the mental age, health, background, and personality of the child was quite plainly painted on the easel. A brief summary of some of their conclusions is given in Table 1.

After a thorough study of Alschuler and Hattwick's experiment, the present experiment was conducted as follows: For approximately four months 21 children were observed two mornings a week in their nursery school environment. The nursery school was divided into two age groups—each supervised by capable teachers. At the conclusion of the observation period the total group was composed of five children under the age of three, 10 children between three and four, and six children between four and five. At all times in this discussion, the children will be referred to by fictitious names.

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[1] Condensation of a master's thesis, University of Texas, 1948.

TABLE 1

Style of painting used	General personality indicated
Emphasis on red	Emotional and personal reaction accompanying good adjustment
Emphasis on blue	Controlled reactions—either repressed or adaptable
Emphasis on yellow	Dependent, infantile development
Emphasis on green	Controlled reactions—sometimes repressed but more often adaptable
Overlaying colors	Dependent, passive, self-centered behavior
Vertical strokes	Assertive and outgoing
Wet strokes	Either controlled behavior or immature behavior
Indiscriminate mixing	Immaturity
Circular strokes	Dependence on others
All directional	Outgoing but lack of control
Short strokes	Impulsive, emotional, well-adapted behavior
Clean products	Controlled, assertive, and adaptive
Dirty products	Social immaturity
Isolated masses of color	Withdrawing, emotionally dependent behavior
Scattered strokes	Less mature and controlled behavior but more assertion and tenseness
Centered products	Self-directed, emotional behavior
Major interest in painting	Repressed and emotional
Minor interest in painting	Realistic, socially adaptable behavior

Two double easels (back to back) were used and were available at all times. A choice of from two to four of the following colors was made spontaneously by each child: red, blue, yellow, or green. A brush was provided for each color and the only instructions given were relative to using each brush only with its own color. A supply of paper was clipped on the easel before the children arrived at school. Each sheet was approximately 16" x 22". Each child had a smock in his locker and was assisted by the teacher in putting it on before painting. In the case of a new or shy child, this rule was not rigidly enforced for fear it might have discouraged the child from participating.

Since the investigator was the only visitor present and was relatively inconspicuous, it was possible to take notes during each period. From this observation the obvious characteristics of each child were recorded. Anecdotes were also recorded when particularly illustrative of each child's general personality. In addition to this observation, all of each child's easel painting, finger painting, and pasting products were collected. (Exception: children who wished to were permitted to take their products home.)

Several conferences were held with the teachers during which much valuable additional information on each child was recorded. The teachers visited each child's home and are responsible for the information concerning the child's family background. Forms filled out by the parents when entering the child in the school were also made available. These forms included such items as the name, age, education, and occupation of the parents; the name, age, birthday, birthplace, and medical history of the child; a brief statement of any of the child's specific problems; and information concerning the child's frequent playmates. In addition to the above, both teachers discussed each child's reactions to various creative mediums—painting, pasting, clay, cutting, dramatic play, and the doll corner.

Lastly, the child's play experiences at home and data on his outward personal characteristics—social, verbal, background, interests, abilities, work habits, and reactions to products—were checked on forms filled by the teachers.

After a thorough study of all the information collected, a summary of each child's characteristics was checked on a special form. Following that, all of the creative products of the child were summarized on three separate forms. The analysis then proceeded and was recorded with the individual case studies.

Of course no child could paint indications of *all* of his personal characteristics on the easel. The problem was to discover exactly which traits did appear most frequently. This was accomplished by the following procedure. All of the children who painted in any one specific style—for example, placed one color over another (overlaid)—were considered as a group. The form on which a summary of each child's personal characteristics had been checked by the nursery school teachers was used as a basis for the analysis. All of these summarizing forms for the children within one style group (e.g., overlay) were compared to discover which traits these children appeared to have in common. All of the traits shown by 80 per cent of the group are included in the final results. For example, in the first summary the six children who overlaid colors comprised a group who, according to their teachers, had four personality traits in common. Since these children also used the same painting style—overlaying of colors—it seems logical to suppose that the one indicates the other. Consideration had to be given the remainder of the children in the school, however. The children in the overlay group might well be very coöperative in routines, but if several children who did not overlay were also coöperative, then it could not be said that overlaying colors was a definite indication of a coöperative attitude. Therefore, the style group had to be compared to the total group of children in the school. After subjecting these figures to statistical analysis, it was discovered that there were 80 chances in 100 that a child who overlaid colors would be more coöperative in routines than a child who did not overlay colors. Only those characteristics which were indicated valid by at least 75 chances in 100 are included in the discussion. A detailed summary of the findings on each painting style follows. Each trait followed by an asterisk was indicated in Alschuler and Hattwick's experiment as valid in the same style group.

B. Results

1. *Overlay: Painting One Color Over Another*

Children who overlaid colors tended to be socially immature. The six children who used this style were more coöperative in such nursery school routines as dressing, drinking fruit juice, etc.,* than the average coöperativeness in the total group. The children who overlaid were also much more dependent emotionally, had no special friends,* and imitated the actions of others* instead of initiating their own actions.

2. *Verticals: Painting Products Which Showed a Predominance of Vertical Strokes*

The lively, aggressive child who feels pride in his products and protects them from interference tends to stress vertical strokes in his paintings. He is easily distracted. He appears to have little plan for play and only accidentally begins his various projects. His activities seem "hit-or-miss"; yet he has a definite feeling of ownership concerning his products.*

3. *Wet Strokes: Thick Products With Many Drippings Obviously Done With a Full Paint Brush*

The well-adjusted child tends to use a full paint brush in his work. Because of this, many drips of paint fall and the product becomes successively thicker as paint is "poured" on it. All 10 of the traits held in common by the children who painted with wet strokes fit the well-adjusted pattern. These children were self-sufficient and coöperative in the nursery school routines of dressing, fruit juice drinking, etc.* They were affectionate* and sympathetic* and as aware of people as of materials. Guests in the nursery school were always noticed by these children. There are 98 chances in 100 that the child who paints with wet strokes will be absorbed in his activities.* He actively seeks play opportunities and materials* and is orderly* and careful* with his products. He has the pride of ownership and resists changes by others.

4. *Indiscriminate Mixing*: *Products on Which Colors Were Blended With No Apparent Plan or Purpose*

Deliberate mixing of colors to achieve a previously-planned result is very seldom done by nursery school children. The more common style is for one color to accidentally cover or blend with another. The child chooses his color, paints a few strokes, exchanges his brush for another color, then *happens* to mix the second color with the first in one or more places. There is no evidence of a deliberate plan to overlay one color with another, nor is there an intermingling of colors such as occurs on the borders of two adjoining forms. The child who mixes colors either does not object to the final result or lacks the control necessary to prevent it.

In general, indiscriminate mixing was done mainly by children who found social adjustment difficult. A preference for emotional activities indicates a child who feels insecure and lives in his own thoughts. He lacks the technique for entering into the group play. He watches others* and is easily distracted. His attention span is short and although he actively seeks something with which to occupy his time,* his attack on each new material is random and accidental.

Of the seven children who mixed colors, Rex was a little gentleman unable to defend himself; Kay's teasing was sometimes resented; Chester was over-excitable and over-aggressive; Bert was exceedingly immature and shy; Stanley was almost completely unable to fit into the group until after several months of adjustment; Neal was never wholly accepted by the group; and May was dependent on adults for almost constant attention, although her over-all pattern was of a fairly good adjustment.

5. *All Directional*: *Products in Which Strokes Were Placed in Every Direction*

Two types of children painted strokes going in every direction. Sam, Chris, and Molly comprised a group whose typical behavior was less mature than was to be expected of a well-adjusted child of that age. Both Chris and Molly did overlay work also—a further indication of their social immaturity.

The remainder of the all-directional group showed some difficulties with social adjustment. All four of them, Kay, Neal, May, and Chester, also did indiscriminate mixing. Reference to the summary of characteristics illustrated by mixing shows that adjustment difficulties were definitely present in each of these children. Kay's teasing was resented, Chester was over-aggressive, May was dependent on adults for constant attention, and Neal was never wholly accepted by the group.

The traits indicated by all-directional painting which seem to particularly apply to the least mature children are: coöperative in routines, affectionate,* sympathetic,* and short attention span.* The less well-adjusted children may be expected to have inconsistencies in the home,* negative and/or aggressive outbursts,* an awareness of people as well as of materials,* a desire for adult attention,* and a determined will.

Various of these traits could apply to either the immature or the less well-adjusted child. From observation Chester, who had adjustment problems, seemed to be very affectionate but lacked the ability to show it in acceptable ways. He hugged children so hard that they were knocked over!

6. *Short Strokes: Products in Which Short Rather Than Proportionate or Long Strokes Predominated*

Children who emphasized short strokes tended to be more aware of adults than the other children in the school. They had good relations with adults and were affectionate and friendly with them. They actively sought play materials—a practice which can be depended on to win adult approval. The children who painted short strokes were the ones who noticed visitors and who talked most to the teacher. With one exception the nine children in this group held the position of either the only child or the oldest child in the family. Experience indicates that both the only child and the oldes child have more reason to be interested in adults.

7. *Dirty Products: Messy, Spattered Products*

The two traits illustrated by dirty products are practically always found together in a child's personality. The child who attacks his work at random with no specific plan tends to change rapidly from one thing to another. This short attention span and random attack are typical of many young children.

8. *Scattered: Products in Which Strokes Were Scattered at Intervals All Over the Page*

Of the 11 children who painted with scattered strokes, 10 had or had previously had adjustment problems. In almost every case the child was trying to solve his problem and was becoming better adjusted. Neal withdrew from nursery school before he was accepted by the group so he had no further opportunity to learn acceptable behavior. Rex progressed from being a perfect little gentleman unable to defend himself to a spirited, active boy quite able to protect his rights. Stanley, at first rejected by the group, later became a willing follower and even occasionally a leader. Hal was over-aggressive and unable to express his affectionate nature, but was beginning to notice new techniques and eventually had special friends. James early lacked confidence and ideas, but later learned to be more self-sufficient and self-confident and became a full member of the group. May required much adult attention, but occasionally seemed quite happy without it, indicating a possibility of a decreased need. Kitty was quite shy on entering the nursery school, but became much more out-going as her adjustment proceeded. Molly's attendance at nursery school was so irregular that there was no real opportunity for her to advance. Chester was over-aggressive, inclined to be excitable, and frequently unable to show affection in acceptable ways. By the end of the term he was much calmer and much better adjusted. Chris was inclined to play alone and had a very determined will, but was beginning to show more interest in the activities of other children. Ellen apparently had no adjustment problems, although she painted scattered strokes.

The following traits are shown by children who produced scattered products: good relation with adults, coöperative with one or more children, initiates contacts, affectionate* friendly with adults, distractible,* short attention span,* random attack toward work,* and emotionally upset at interference.

9. *Circular Strokes*: *Products in Which Circles or Circular Strokes Predominated*

Children who painted with circular rather than vertical, horizontal, or angular strokes were inclined to be friendly with adults.* They were easily distracted and had a short attention span with a random attack toward work. They actively sought materials and opportunities for play. All of these traits are commonly found together in nursery school children.

10. *Centered*: *Products in Which the Main Portion of the Paint Was Centered on the Page*

Children who did centered work showed an interest in stories and books* and an independence or unawareness of adults. Sixteen out of the 21 children in the whole group painted centered products. Since both mature, immature, adjusted, and unadjusted children are in this group, and only two traits are strongly indicated, a generalization of the specific type of personality which does centered work is difficult.

11. *Two Case Studies*

Of the 21 children included in this experiment, two cases have been selected to illustrate the amount and type of information which was collected on each child. The inclusion of these brief biographical summaries also tends to clarify the results.

a. Chris. Age during observation: 2-3 to 2-7. Chris was a very short, chubby little boy who had been adopted as a baby. His foster sister, about two years older, had also been adopted. Their foster-father was a partner in a successful business and the family income was apparently high. At home Chris shared a bedroom and a toy room with his sister. Large equipment was plentiful but much of the indoor materials were too advanced or otherwise inadequate. Practically no stories or books were in evidence and the children seemed to have no interest in them. The children were left in the care of "sitters" several nights a week. Verbal emphasis in the home was on very high morals. Church was a dominating family interest. The parents engaged in many social activities in the church and also in public recreation centers. Very high standards were held for the children in some matters. For example, they were expected to be very generous, courteous, and kind. In other respects less strictness of standards was observed. For example, the parents did not expect the children to assist in dressing themselves. Chris' father seemed especially fond of him. Both parents were very interested in and attached to the children.

At nursery school Chris was adaptable and popular, though he had no special friends. He was quite immature and sought considerable attention. He played alone most of the time but could initiate contacts and was either aggressive or affectionate with other children. He was friendly with and dependent on adults. Chris' attention-span was short and his choice of materials accidental. He had little interest in his products and either accepted changes in them or was emotionally upset at interference—according to his mood. Chris was inclined to have emotional outbursts and negative-aggressive periods. He was easily and quickly angered by inanimate objects. A typical situation showed Chris sitting on the big tricycle howling loudly because his feet wouldn't reach the pedals while the smaller tricycle stood idle beside him.

Chris seemed to enjoy all he did with creative materials but had few interests. He pounded crayons and clay and mixed finger paints with obvious pleasure. In the doll corner he occasionally entered a tea-party game. With blocks, he either made simple objects or threw the blocks about the room. His favorite indoor occupation seemed to be working puzzles and looking at books, neither of which he had at home. He obviously enjoyed active outdoor play more than indoor activities, however.

Chris had an average interest in the easel and produced messy products with scattered, all-directional, and overlay work predominating. His strokes were frequently short and he somewhat favored red as a color. In general his products were typical for his stage of development. Scattered, all-directional, and overlay are the predominating styles used by the very young, socially immature child. Red is an emotional color much preferred by many children. If Chris had painted immediately after the tricycle episode above he would probably have used red paint to portray his disturbance.

b. Cleo. Age during observation: 3-7 to 3-11. Cleo was a quiet, attractive little girl who appeared to play perfectly happily in her own company. Her parents were well-educated and her father held a high professional position. Cleo had one sister two years her senior. She shared a bedroom and a playroom with her sister. Her play equipment was excellent in both quantity and quality. Playmates at home included the sister and a boy nearer the sister's age. Cleo was usually given a minor rôle in their play.

Her sister had previously been the playmate of an older brother not living now. The parents and sister both showed indications of continuing emotional stress over the boy's death. Several of the parents' actions seemed to point to some partiality toward Cleo. Family relations on the whole were good, however. The children seemed very fond of their father. Both parents were interested and understanding, and Cleo was given a good opportunity to develop her possibilities.

At nursery school the two most obvious points of observation concerning Cleo were these: she played almost always alone; she seemed very contented. Cleo was adaptable and very self-sufficient. Her own play indicated that she had ideas and initiative although she seldom took a leading part in the group. She was dependent emotionally in a shy, quiet way, but usually avoided the attention of children. No one disliked her, but she appeared to have no special friends. She played alone or with one other child and spent much time watching others while holding a doll or other toy. Cleo was affectionate and friendly with children and was interested in adults and adult attention. She talked very little and with adults the conversation tended to be personal. Cleo had a long attention-span and did orderly, patient work in which she was absorbed. She made careful, detailed plans and held high standards. When interfered with she was emotionally upset and attacked her aggressors.

Cleo's favorite activities at nursery school were playing in the doll corner, painting at the easel, and entering into all types of outdoor play. She spent long periods with the dolls and sometimes used them as a vantage point from which to watch others. She had an average interest in clay and finger paints and did recognizable crayon products which she named "lady" frequently. She liked pasting also. Cleo seldom entered into dramatic play indoors but occasionally did outdoors. She liked stories, books, and music. In rhythms she waited until all the others were through, then marched or jumped alone.

Cleo spent long, absorbed periods at the easel. She frequently painted several pictures and took many home. She was interested in her products and sometimes named them. Her usual style portrayed a wet-centered mass. Painting with a very wet brush is typical of the well adjusted, socially adaptable child.

C. CONCLUSIONS

In this experiment a large number of products were collected from each child over a period of several months. Future research might well investigate the validity of results obtained by analyzing a very few products painted over a very short period of time. Other problems which have not yet been solved in this field are: Do older children show the same traits by the same styles? At what age does easel painting cease to be a valid personality index because of adult art teachings which the child has received? What styles do children of different races and/or social backgrounds paint? How do mentally and/or physically handicapped children indicate their problems in their paintings? The technique is so new that research in it is almost unlimited. It is to be hoped that the results of this study will encourage the readers to initiate many new experiments of their own.

Easel painting used as a projective technique by a trained and experienced teacher is a valuable source of information about the most intimate interests and problems of children. Any technique used by an untrained person can do a great deal of harm. A child who has adjustment problems needs an early and correct diagnosis of his problems. If the diagnosis is inadequate and/or incorrect, positive action toward solving the problem is either postponed or impossible. Easel painting does not provide a definite list of characteristics to fit a definite style of painting. One can never say, "He paints . . . so his characteristics are 1, 2, and 3." On the contrary! The more complete the information about the child's background, experiences, interests, and abilities, the more valid the results obtained by any projective technique. And valid results are obtained *only* in conjunction with such supplementary information about the child. A projective technique is not an arithmetical process in which 2 plus 2 is always 4. Rather, a projective technique should be used to enable one to understand others.

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A FINAL FOLLOW-UP STUDY OF ONE HUNDRED ADOPTED CHILDREN*[1]

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A. HISTORICAL BACKGROUND

While there have been a substantial number of studies reporting the intelligence status of foster children (16, 19, 20, 21, 28, 30) repeated evaluations of the same children into adolescence or early adulthood have been rare. This report constitutes what will probably be a final chapter in a long range study in which the same group of adopted children have had intelligence tests on four occasions. Reports of the results of the first three examinations (24, 25, 26) provoked a great deal of discussion and many questions regarding the *IQ* and the rôle of heredity in determining the eventual status of the children. The intensity of the debates over the relative functions of environment and heredity has dissipated in the past decade as evidence from other studies has shown that modifiability of intelligence is not an unusual phenomenon (13, 15, 22, 23, 28).

As it now appears unlikely that children in this study will be revisited, this report will include details and certain raw data which may be of value to others contemplating similar research. Many problems remain unsolved and an account of practical difficulties may expedite the inevitable preliminary steps in other studies.

The study originally began, not as a research, but as a service project. This difference in orientation accounts for some of the gaps in information, for the techniques selected and for the general planning, which might have been done otherwise had the project been conceived primarily as research. However, there is a practical question of whether the study could have been accomplished at all had it been weighted down with all the scientific safeguards which the perspective of 15 years of study might have suggested. Because of its simplicity and apparent inoccuousness, the study was accepted by lay people, parents, and children with a minimum of explanation.

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This study was made possible when the Board of Control of State Institutions of Iowa instituted psychological services in connection with its Children's Division in 1934. The staff consisted of Harold M. Skeels, Director and Psychologist, and Marie Skodak, Assistant Psychologist. Liaison relations with the Child Welfare Research Station of the State University of Iowa were established through the half-time appointment of Dr. Skeels with that institution. Through coöperative relations with the staff of the Child Welfare Research Station it was possible to amass a substantial body of reliable data on the mental status of the residents of the children's institutions and also to free the regular staff members of the Children's Division for work outside the institutions.

One of the major extramural projects was the examination of all children who had been placed in foster homes and who were about to be legally adopted. While children of all ages were involved, by far the majority were younger children who had been placed as infants. The policies of the institution were determined by an appointed Board who were not selected for academic qualifications or experience in social work or psychology. At that time, neither the Board, nor the institutional staffs, nor the field workers who supervised the children included a single person who had had any formal training or who could be described as a "qualified trained social worker." The head of the Children's Division was a qualified person but was relatively powerless to institute so-called modern social work methods in the face of various pressures. The children were accepted for care in institutions, cared for while in the institutions, and placed in free, wage, or adopting homes largely on the basis of "good common sense" as well as the good judgment or whims of the workers as modified by prevailing pressures or policies. While this rather casual modus operandi produced miscarriages of optimum planning, these were not as numerous as might be feared. The general atmosphere with regard to the younger children was one of sentimental pity rather than punitive aggressiveness, though the latter was not uncommon with the older children. The pressure of physical overcrowding and the demand for children for adoption together with the generally unsophisticated and homey attitude, resulted in a tendency to place children in foster homes at the earliest possible time. Since there were no provisions for boarding funds, the following alternatives were available: (*a*) Wage homes, where in return for services the child received care and some weekly wage or allowance. These were obviously the older children who had usually had some preliminary training in the institution. (*b*) Free homes, where the child was "treated like one of the family" without legal adoption. He remained a ward of the state, could be removed at the discretion of the supervisor, be returned by the family, or eventually be adopted. Children of all ages were so placed, but the majority were in the elementary school ages. (*c*) Adoptive homes, wherein, after a year of probationary residence, the child was legally adopted. During the probationary residence the child was visited several times by the field worker to determine the adequacy of the care the child received, the compatibility of the parents and child, and to check on the child's development. While children of all ages were placed in adoptive homes, the great majority were infants and preschoolers and in the majority of cases legal adoption was completed within two years after placement. After adoption there were no more official relationships between the family and the institution or the Children's Division.

The extramural services of the psychologists on the one hand provided examination and consultation facilities for those homes where behavior problems were encountered, primarily with older children, and on the other hand offered psychological evaluation of children about to be adopted. The primary purpose of this was to guard against the adoption of mentally retarded children as well as to offer the services of a child development specialist to aid in problems which the adopting parents might encounter or might anticipate.

Through the coöperative arrangements with the University it was possible to offer a similar service during 1934-36 to the Iowa Children's Home Society, a private state-wide child placing agency. This organization, with a better trained staff and boarding home facilities, also placed a substantial number of children in early infancy and arranged for the pre-adoption examination as an additional service to the adopting parents.

Another extramural service performed by the psychologists was the examination of children, and occasionally the mothers of illegitimate infants, where there was a probability that the children would become wards of the state. This preliminary information facilitated the proper institutional assignment and subsequent planning for the children. Since the examinations were frequently conducted in the homes or at a nearby school, the psychologists had an invaluable opportunity to see at first hand the home, neighborhood, and often the relatives constituting the child's early environment or his social-economic heritage.

The foster homes into which the children were placed became available through a number of sources. The child-placing programs of the State Board of Control and the Iowa Children's Home Society were well known throughout the state since the majority of agency placements were made through them. Both organizations had travelling workers, assigned to certain areas whose duties included: (*a*) The supervision of children placed in wage, free, and adoptive homes to insure proper care, protection, education, and home relationships. (*b*) The evaluation of homes and foster families for children in terms of financial resources, physical set-up, attitudes toward children, future demands on children. (*c*) The development of community interest in child care, adoption, and placement.

Parents interested in adoption would write directly to the state office, the institution, agency, or one of the field workers. The application blanks contained only the minimum information regarding the type of child desired, the family's financial and vocational status, and the names of at least three references. The field worker would then visit the home, interview the applicants, evaluate the physical and emotional resources and the possible future demands with regard to education and vocation. References were contacted by mail, phone, or visit. The degree of investigation varied. Families who were well known or who were manifestly capable were accepted with less scrutiny than families in more modest circumstances or where there were questions regarding the present or future adequacy of the home. It is not known what proportion of applicants were rejected, but in many cases families were dissuaded from completing an application if it seemed unlikely that a child would be placed with them.

On the whole the foster families were above the average of their communities in economic security and educational and cultural status. They were highly regarded by the town's business, professional, and religious leaders and usually had demonstrated a long-time interest in children through church or community activities.

The placement procedure in both organizations was essentially similar. In the state agency after the application was accepted the family was placed on the waiting list and their name was considered at the monthly staff meetings when assignments were made. At these case conferences, attended by the head of the Children's Division, the superintendent of the institution, the psychologists, and head nurse, the available babies and available homes were discussed. Factors in the assignment included religion, sex, age, color or complexion, physique, medical history, and report of the family background. Pre-placement psychological examinations were not available for the children in this study. In many instances the information about the child's family background was so meagre that it was of little or no value. The primary factors in matching were the stipulations of the foster parents regarding religion, sex, and hair color in that order.

This method of placement of children from relatively inferior socio-economic backgrounds into substantial homes thus provided the setting for the study. Perusal of the child's social history as recorded in the institution and comparison with the field's agent's pre-placement evaluation of the adopting home was disheartening. It did not seem possible that children with such meager possibilities, as projected from the intellectual, academic, and occupational attainments of their parents, could measure up to the demands of cultured, educated parents. Yet careful examination of one child after another showed none of the retardation or misplacement which might have been anticipated. Following a preliminary survey of results (24) it was decided that a follow-up study was imperative, and the coöperation of the foster parents was solicited and received.

B. DESCRIPTION OF THE SAMPLE

A detailed report of the population of which the children in this study constitute a sample was presented in 1945 (26).

In general there are three levels of society from which children for adoptive placements originate. It is believed that children from culturally, socially, and educationally superior homes tend to be placed among relatives or in adoptive homes through various private sources. Because of the extreme difficulty of identifying and locating such placements, no studies have been made of the subsequent development or adjustment of these children, nor is the exact number of these children known to official agencies. At what may be described as the second socio-economic level, the children tend to become the charges of private or semi-private child caring or placing agencies. Many of these children's aid and protective societies exercise considerable control over their intake. Policies may, for instance, preclude the acceptance of children of mentally defective parents, or of other children who may be judged "unplaceable" or in need of care which that particular organization does not feel equipped to offer. These organizations tend to draw from the various middle economic classes but also have a fair number of children from extremely ineffective homes as the study by Roe and Burks indicates (21). The third group of children from the lowest socio-economic levels are usually known to various public welfare agencies. The public agencies, in contrast to the private ones, are usually obligated to accept all children committed to their care and naturally receive children no other agency feels able to accept. There is no doubt that the general social, vocational, and adjustment level of the parents of children committed to public agency care is substantially below that of children who become wards of private agencies or who are adopted through private channels.

It is necessary to differentiate between observations regarding the natural families of infants committed for care and the natural families of preschool or older children. All studies which have published reports on the education of the true parents of children placed in foster homes agree that the true parents of the older children are more apt to be inadequate, unstable, retarded, unemployed, in other words, less competent by any criterion of measurement which has been used. The social factors behind this difference are not difficult to identify. The youngest children, the infants, are primarily illegitimate children. In the first place, their parents are relatively younger. While parents-out-of-wedlock show various signs of emotional instability, the psychoses, alcoholism, and cumulating effects of maladjustment characterizing the parents of older dependent children have not yet indelibly affixed themselves. With the rest of their generation, the younger parents enjoy higher educational opportunities together with the dubious benefits of being "lifted" from grade to grade on the basis of physical size rather than academic accomplishment. Vocationally it is understandable that an 18-year-old youth is a farm hand or truck driver's helper, while an adult of 40 on the same job is prima facie scored well down on the scale of occupational success. The young illegitimate parents have not had the accumulating frustration of economic deprivation, children in unwanted numbers, and the growing weight of community disapproval of their inefficient way of living. For many it is the first, and often the only, social transgression and after this experience many, perhaps even the majority of illegitimate parents, go on to establish secure, socially acceptable homes and families. A study of what happens to illegitimate parents who decide to establish a family together, as compared to those who release their child, may shed some interesting light on the factors which operate to produce the poorer histories among the older children as compared to the younger. There is a significant socio-economic difference between the parents of the younger and older groups of children who become dependent. It does not necessarily follow, however, that this difference is genetically determined.

1. *Subjects of This Study*

The criteria for inclusion in this study were as follows: (*a*) The child was placed in an adoptive home under the age of six months. (*b*) The child had been given an intelligence test prior to November, 1936, and after one year's residence in the adoptive home. (*c*) Some information, though of variable amount and reliability, existed concerning the natural and the adoptive parents. (*d*) The child was white, of North European background (it so happened that no children of South European, Latin, or other social backgrounds met the other criteria either).

In this study all of the children were received for care as infants. The Iowa Soldiers' Orphan's Home, identified as the public agency, was the placing agency in 76 per cent of the cases and the Iowa Children's Home Society, a state-wide, private, non-sectarian organization placed 21 per cent. The remaining three children were privately placed and were included because they were available and met the criteria set up for the other children.

It was earlier pointed out (26) that 96.6 per cent of the 319 children committed to the two agencies under the age of six months between 1933-1937, were placed in adoptive homes. In only four cases was the child withheld from adoptive placement because of poor family history. The remaining seven had serious health problems. Since the majority of the children originally in the study had been placed during this period, and the remainder had been placed earlier during a time when the policies regarding family background had been even more lenient, it was concluded that the children in the study were representative of all those placed by these organizations.

During 1934-36, when the mental testing program was coördinated for the two agencies, and 1933-37 for the public agency alone, it was found that 90 per cent of the children placed under six months of age had been given at least one intelligence test. The mean *IQ* of this group was 119, slightly above the mean *IQ* of 116 achieved by the members of the follow-up group on the first examination during the same calendar years.

It was evident that the group of children who constituted the first sample were representative of the available children since there was no systematic withholding of numbers of children because of poor histories, nor was there a group with lower initial intelligence test scores who were excluded from the study.

In the first follow-up report (25), out of a total of 180 children who met the criteria of age at placement, race and date of examination, it was possible to retest 152 children during 1937-38. On the third examination 139 children were seen during 1940-41 (26) and the fourth and final visit in 1946 resulted in the present sample of 100. The major factor in the reduction of the size of the sample has been time and expense. The families, all originally in Iowa, are now scattered over many states and Canada. To locate and visit the 100 children in the 10 weeks available for the study, it was necessary to drive over 12,000 miles even though accurate addresses were available and careful preliminary arrangements had been made with planned appointments acceptable for the parents and the child.

a. Losses between Test I and Test II. A total of 180 children under six months of age had had an intelligence test prior to November, 1936. The first re-examinations were given between December of 1936 and October of 1937. A few children were excluded because less than a year had elapsed since the first examination, but the majority were dropped because travel schedules and the convenience of the family did not happen to coincide. Four families did not wish to coöperate further. Twenty-two families either could not be located, were known to have left the state, or could not be conveniently scheduled for retests.

b. Losses between Test II and Test III. Between 1937 and the third examination in the summers of 1939 and 1940, the sample decreased from 154 to 139. The 15 children who dropped out of the study at this point included 10 who had moved out of the state, four whose families refused to coöperate further, and one who was returned to the institution because of the cruelty and neglect of the foster parents.

c. Losses between Test III and Test IV. Between 1940 and 1946 World War II was fought, and research was immobilized by gas and tire rationing and the universal shortage of professional personnel. A fortunate combination of circumstances freed the author (M.S.) who has given the majority of the tests, for a 10-week period. The preliminary planning and a preliminary registered-mail inquiry, with a questionnaire to be returned by the family, facilitated the optimum utilization of time. A copy of the letter and questionnaire may be found in the Appendix. At the time of the fourth examination, seven additional families declined to coöperate further, eight had moved from the state, two were contacted but could not be scheduled because of various conflicts, and the remaining 22 did not respond or could not be reached by registered mail through their 1940 address. On the basis of the letters received from the parents who had moved and from previous knowledge of the families from whom no response was received, it is estimated that approximately 20 of these children could have been seen had time and funds permitted.

The comparisons between the continuous group of 100 and those who dropped out at the various retest points, are given in Table 1.

These figures account for the original 180 children who met the qualifications for age at placement in an adoptive home and date of first examination. Systematic selection which would influence the character of the final group of 100 is not evident from the comparisons between the mean *IQ*'s of the group

TABLE 1

	Test I	Test II	Test III
Continuous Group (*N* 100)	117	112	115
Dropped after 1940 (*N* 39)	113	107	110
Dropped after 1937 (*N* 15)	114	111	
Dropped after 1936 (*N* 26)	120		

at the various re-examination periods. The standard deviations for all means are large, ranging from 11.9 to 17.2, and none of the differences is statistically significant.

It may be concluded that this group of 100 children is probably representative of the total group placed by these agencies at comparable ages, and that conclusions based on the pattern of mental development of these children are probably applicable to others with similar experience and social backgrounds and placed under similar circumstances into comparable homes.

2. *Test Techniques*

The purpose throughout the study was to secure the most reliable and valid measure of the child's intellectual ability at the time of the examination. On first examination the children ranged from 11 months to six years in age with 78 per cent of the children between one and three years. Four children had been placed at a few days of age and were tested shortly before the expiration of the one-year observation period. The 1916 Stanford-Binet was suitable for use with the 19 per cent over three years of age and was occasionally used with younger children who were obviously accelerated in mental development. The Kuhlman Binet was routinely used with all children under three years, and occasionally as a clinical supplement with some children over three.

The re-examinations were begun in 1936 when the Revised Stanford-Binet was not generally available and the 1916 revision was consequently used. In this series of tests, although 17 per cent of the children were under 3-0 years of age, they were all over 2-6 and sufficiently accelerated to make the 1916 Stanford-Binet a usable test. Therefore, all test scores reported for the second examination were based on the 1916 revision.

When the third examination was scheduled in 1939-40, the question of "best test" was raised. From the standpoint of fatigue and future rapport, it seemed advisable to limit the number of tests given and the 1916 revision was again selected. Survey of the literature (7, 14, 18) showed that between 5 and 11 years, the ages of these children at the third examination, the results of the 1916 and 1937 scales were most nearly identical. Not only had the 1916 test been used in the earlier examinations, but it also had been used in examinations of the mothers and a few of the fathers of the children. Direct comparisons of test scores were thus made possible without getting into the knotty problems of comparability of standardization of the different revisions. The problems of such a long-time research underscore the need for an intelligence test which results in comparable scores at all ages.

When the fourth and last examination was scheduled in 1946, the children were between 11 and 17 years of age. In view of the problems surrounding the 1916 revision at these ages, it was decided to impose on the good nature of the subjects and give both the 1916 revision and Form L of the 1937 revision. This set up a program involving approximately two hours, often a great deal more, if there was marked scatter on either or both tests. Since there are a number of overlapping items, these were given and scored simultaneously. The 1916 revision was completed first and the 1937, Form *L*, second. Whatever advantage of practise effect there might have been, was judged to be cancelled by fatigue. Every effort was made to keep the interest and effort of the examinees at an optimum level. No subject refused to take the tests after an appointment was made and only two were openly antagonistic in typical adolescent behavior. Even these were persuaded to cooperate and no greater compliment to the intrinsic interests of the tests can be made than to say that in spite of themselves even these reluctant subjects became interested and made scores consistent with their earlier test results and their current school placements.

All of the third and fourth tests, and all but five or six of the first two tests were given in the foster homes. This made it possible to observe the relationships between child and parents, the fluctuation in family economic and cultural status over the 13-year period, and to sample the child's behavior in the home situation. A cordial relationship developed between the parents and the examiners as a result of these repeated visits. The first examination was usually a highly emotional experience for the parents, who understood that the psychologist's word was final in approving or disapproving the completion of adoption. In a sense this was even more crucial than the court action since as one parent stated "we were taking an examination in parenthood. Our success was shown by the results in our child." The majority of the families, located in areas where clinics and psychologists were not available but who were familiar with these resources through reading and the radio, availed themselves of the opportunity to discuss various child rearing problems. As would be anticipated, the character of the problems changed with age, and on the fourth visit dealt with problems of adolescence, vocational choices, educational plans, emancipation from the home, etc. There seemed to be no problem which was unique to this group of children as compared to any other group of similar age. The problem of information concerning their own adoption had been well solved by nearly all the families. Surprisingly enough two families had still not "told," but other evidence indicated that these children probably guessed. In two or three instances there had been community problems in which, despite the efforts of the foster parents, the children had had a very difficult adjustment to the adoptive status.

All the parents were aware of the research nature of the re-tests and were, on the whole, proud of the distinction. Through their contribution they felt they could facilitate early placement of children in adoptive homes and provide reassurance to families uncertain about adoption.

Relationships between the children and the examiners were more casual. Some of the children recalled the examiner's visits from one occasion to the next, and when they did, it was in terms of the fun of playing games with an unusually agreeable person. An explanation was made to all participants during the fourth examination following the general pattern that:

> When you were a younger boy, you were a member of a group of boys and girls all over the state who were given tests like this. We wanted to find out how well children could do different sorts of things, how well they could remember, figure things out and so on. Now that they are older, we would like to see how much they have changed and in what way. The tests are a little like a quiz program on the radio and most people find them rather fun.

In a few instances the question was raised as to whether children who were not adopted were also tested and the subjects were assured that children in many places also took similar tests. Two of the participants, one, the oldest subject, who had completed one year in college, and one a superior high school senior with decided research interests, were familiar with the published reports of the study and coöperated delightfully.

C. Mental Development of the Children

All of the children had been seen on four occasions and a few for various reasons had been given additional tests. In these cases the test given at an age nearest the mean age for the group was selected for use in the major comparisons. Distribution of the ages at which the tests were given is presented in Table 2. The mean age at first examination was *2 years 2 months,* at second examination *4 years 3 months,* at third examination *7 years 0 months* and at fourth examination *13 years 6 months.*

TABLE 2
AGES OF 100 FOSTER CHILDREN AT TIME OF TEST

Chronological age	Test I	Test II	Test III	Test IV
0-6 to 0-11	3			
1-0 to 1-11	55			
2-0 to 2-11	23			
3-0 to 3-11	12	28		
4-0 to 4-11	4	33	2	
5-0 to 5-11	2	12	15	
6-0 to 6-11	1	4	53	
7-0 to 7-11		5	7	
8-0 to 8-11			14	
9-0 to 9-11		1	2	
10-0 to 10-11			6	
11-0 to 11-11			1	13
12-0 to 12-11				25
13-0 to 13-11				38
14-0 to 14-11				12
15-0 to 15-11				5
16-0 to 16-11				5
17-0 to 17-11				1
18-0 to 18-11				1
Number	100	100	100	100
Mean	2 years, 2.3 months	4 years, 3.4 months	7 years, .1 month	13 years, 5.8 months
Median	1 year 10.2 months	4 years, 1.9 months	6 years, 7.5 months	13 years, 4.8 months
Standard Deviation	13.08 (mo.)	16.4 (mo.)	17.0 (mo.)	16.3 (mo.)

The group included 60 girls and 40 boys. The range, median, and mean ages for both sexes were essentially the same.

Table 3 shows the results of the examination described earlier. Ages and results may be summarized for the 100 children as given in Table 4.

The mean *IQ* of this group of children has remained above the average for the general population throughout early childhood, school age, and into adolescence. It would be generally accepted that if major changes in intellectual functioning occur after this age, they probably result from psychiatric and emotional problems rather than from developmental abnormalities.

An interesting problem in test evaluation is posed by the results from the "simultaneous" administration of the 1916 and 1937 Stanford tests. Comparative studies of the 1916 and 1937 revisions support the general impression of clinicians that the 1937 revision tends to overrate the average or above average adolescent, while the 1916 revision tends to underrate him. This dilemma was frequently encountered in the examination of these children since differences of 15-20 points between the two tests were moderately

TABLE 3
IQ DISTRIBUTION OF TESTS OF CHILDREN IN FOLLOW-UP STUDY

IQ	Test I	Test II	Test III	Test IV (1916-S.B.) (*CA* to 16)	Test IV (1916-S.B.) (*T-M* Table)	Test IV (1937-S.B.) (Form *L.*)
150-154	1					1
145-149	0	2	2			1
140-144	3	1	2	1	1	3
135-139	6	3	3	0	0	7
130-134	5	9	4	2	2	12
125-129	15	5	16	7	11	6
120-124	14	8	6	11	9	14
115-119	15	8	16	12	16	13
110-114	12	20	17	12	9	14
105-109	10	17	13	15	16	10
100-104	8	11	9	13	16	9
95- 99	7	5	6	10	4	2
90- 94	1	7	3	5	6	3
85- 89	1	4	2	5	4	0
80- 84	2		1	2	3	3
75- 79				2	1	1
70- 74				2	2	1
65- 69				1		
Number	100	100	100	100	100	100
Mean	116.8	112.4	114.8	107.1	108.8	116.8
Median	117.5	111.0	114.2	107.85	108.9	117.2
SD	13.55	13.75	13.20	14.40	13.90	15.45

TABLE 4

Test	Age	Mean *IQ*	*SD*	Range	Median
I	2 yrs. 2 mo.	117	13.6	80-154	118
II	4 yrs. 3 mo.	112	13.8	85-149	111
III	7 yrs. 0 mo.	115	13.2	80-149	114
IV (1916)	13 yrs. 6 mo.	107	14.4	65-144	107
IV (1937)	13 yrs. 6 mo.	117	15.5	70-154	117

frequent. Years of clinical and guidance experience with young people of these ages provided a background against which the quality of their responses, their school achievement and their general intellectual maturity as evaluated from an interview could be projected. The result was a feeling of dissatisfaction with both tests and a fervent wish that a more adequate instrument were available.

The test results are presented here as they were obtained. In computing the *IQ* on the 1916 tests, 16 years was used as the maximum divisor, following Terman's instructions. In computing the *IQ* on Form *L*, the Terman-Merrill tables were used, which provide for a gradual rather than abrupt change in relationship between chronological and mental age. The next to last column in Table 3 shows the effect of using the same Terman-Merrill table with the mental age secured on the 1916 Stanford-Binet. There is a slight rise in mean *IQ* from the corrective effects of the table but this is not enough to account for the total difference between the two tests. The difference, however, is not statistically significant (*CR* 1.6) but its consistency and general character is shown in both Table 5 and the detailed presentation in the Appendix.

The general trend of *IQ*'s where the tests are distributed by age, is shown in Table 5. *IQ*'s reported for years one and two are based on the Kuhlmann scale, for years 3-10 the 1916 Stanford, and years 11-15 the 1916 and 1937 Stanford as indicated. Beyond 14 years of age the number of subjects in each age group was too small to warrant inclusion. The small number of cases at 10 and 11 years resulted from the long interval between third and fourth examinations. Repeated cross section analysis of the results shows that the group has consistently achieved a higher average mental age than would be found in a representative sampling of the total child population of the same age. Detailed statistical analysis of this material is not possible since every test for each child is presented, including some which are not used in the major comparisons. While fluctuations do occur, accentuated by the small numbers of cases at single age levels, the findings are essentially the same

TABLE 5

IQ BY AGE AT TEST

IQ	Age—years 1	2	3	4	5	6	7	8	9	
155-159										155-159
150-154		1								150-154
145-149			1	1		2				145-149
140-144	3			1		1				140-144
135-139	3	3	1	2		2	1	1		135-139
130-134	2	2	4	6		1	2		1	130-134
125-129	7	7	1	4	3	5	4	1	2	125-129
120-124	6	6	4	2	4	4	1	1	1	120-124
115-119	4	7	6	3	4	7	2	4	1	115-119
110-114	4	9	5	6	4	9	6	2	2	110-114
105-109	6	4	3	5	6	7	5	1	1	105-109
100-104	3	4	1	6	1	5	4	1	1	100-104
95- 99	1	3	4	2	3		2	2	1	95- 99
90- 94			1	4	2	1	2	1		90- 94
85- 89			1	3		1		1		85- 89
80- 84			1			1		1		80- 84
75- 79										75- 79
70- 74										70- 74
65- 69										65- 69
60- 64										60- 64
Number	39	46	33	45	27	46	29	16	10	
Mean	120.10	117.45	113.95	113.35	111.25	115.50	112.35	108.85	115.5	
Median	120.75	116.64	114.92	111.58	111.38	113.94	110.75	112.0	114.5	
SD	12.20	11.85	14.65	16.0	10.35	13.80	12.10	14.55	10.95	

TABLE 5 (*continued*)

	Age—years 10	11 SB '16	SB '37	12 SB '16	SB '37	13 SB '16	SB '37	14 SB '16	SB '37	
155-159										155-159
150-154							1			150-154
145-149							1			145-149
140-144			1			1	1		1	140-144
135-139			2		1		2		1	135-139
130-134		1		1	3		5		1	130-134
125-129	1	3	1	1		2	4	1		125-129
120-124			1	2	3	8	4	2	5	120-124
115-119	2		1	3	3	7	5		4	115-119
110-114		1		1	4	2	3	5	3	110-114
105-109	2	1	1	5	2	5	4	3	2	105-109
100-104		2		4	1	3	2	4	5	100-104
95- 99				1	1	1		4	1	95- 99
90- 94				1		3			1	90- 94
85- 89		1						5		85- 89
80- 84		1				1	1		1	80- 84
75- 79							1	1		75- 79
70- 74						1				70- 74
65- 69										65- 69
60- 64										60- 64
Number	5	10	7	19	18	34	34	25	25	
Mean	114.0	110.5	127.0	110.4	117.39	111.25	120.10	102.40	112.80	
Median	115.75	109.5	127.0	108.0	116.17	115.21	120.75	102.63	113.67	
SD	7.15	16.75	11.65	10.25	10.75	14.0	15.90	12.40	13.55	

as in the earlier reports. The mean *IQ* of this group has remained consistently above the average of the population as a whole at each age level.

TABLE 6
CHANGES IN *IQ* BETWEEN TESTS

	Between Test I and II Number	Between Test II and III Number	Between Test III and IV '16 Number	Between Test III and IV '37 Number
+36 to +40				
+26 to +35	1	4		
+16 to +25	7	7	1	1
+ 6 to +15	11	26	12	14
— 5 to + 5	34	42	30	32
— 6 to —15	25	17	30	34
—16 to —25	18	4	25	18
—26 to —35	3		2	1
—36 to —45				
—46 to —50	1			
Total	100	100	100	100

	Between Tests I and III Number	Between Tests I and IV '16 Number	Between Tests III and IV '37 Number
+36 to +40	2		
+26 to +35	2	2	2
+16 to +25	5	5	5
+ 6 to +15	21	12	14
— 5 to + 5	30	19	21
— 6 to —15	23	29	29
—16 to —25	13	16	14
—26 to —35	3	11	10
—36 to —45	1	6	5
—46 to —50			
Total	100	100	100

	Between Tests II and IV '16 Number	Between Tests II and IV '37 Number
+36 to +40		
+26 to +35		1
+16 to +25	8	8
+ 6 to +15	15	17
— 5 to + 5	22	26
— 6 to —15	31	31
—16 to —25	21	14
—26 to —35	3	3
—36 to —45		
—46 to —50		
Total	100	100

Rather wide fluctuations in *IQ* between tests were found throughout the entire period. Table 6 summarizes the changes found. The general trend is toward losses when the first test is taken as the basis of comparison, as the mean *IQ* on succeeding tests would indicate. Since the total number of cases is 100, the percentages may be computed automatically and only the actual number of cases is given in the table.

These results, together with the correlations reported later, are consistent with findings from other studies, (3, 4, 13, 23) which show that *IQ* fluctuations of considerable magnitude are found among children who live with their own parents. The greater the time span between tests the greater the probability of wide difference between successive test scores. From a clinical standpoint this serves as an additional caution in the use of a single test score in long range prediction of intellectual attainment. Yet inspection of the raw data for individuals, as shown in the Appendix, gives somewhat more assurance. By and large the children did not change their positions relative to the population as a whole as drastically as these figures might lead one to conclude. When marked changes occurred there were related factors which could usually be identified in the individual instances.

Correlations between successive tests may be summarized as given in Table 7.

TABLE 7

	Test II	Test III	Test IV '16	Test IV '37
Test I	.54±.05	.44±.06	.35±.06	.35±.06
Test II		.70±.03	.58±.05	.59±.04
Test III			.71±.03	.75±.03
Test IV '16				.92±.01

These correlations do not differ markedly from those reported in other studies (2, 11) where the retests are separated by similar time intervals. From the standpoint of prediction of individual status in terms of the child's future *IQ*, the early tests may be considered disappointing, yet this group is not unique in its variability or its fluctuation from one examination to the next.

Of special interest are those children whose early mental development was average and who as adolescents are below 85 *IQ*. These cases, numbered 41G, 47G, 48G, 76G, 81G, 82G, 23B in the Appendix, include five children who occasioned concern from the beginning of the study. Three of them have been seen by psychiatrists at the initiative of the parents and are the only children in the group who have been referred for such help. No. 41G is a shy, diffident compulsive neurotic who is described as a meticulous housekeeper, who doesn't leave a task until it is complete in every detail. Characteristically she does poorly wherever there is a time limit and fails all tests at school though her homework is perfect and her individual reports to the teachers are good. She repeated the eighth grade, but in a medium sized high school she is a *B* student. It was felt that the 1916 Stanford-Binet *IQ* of 79 did not adequately represent her functional level. Nos. 82G and 76G are two of the disturbed children in the study. They have long histories of inexplicable erratic behavior similar to that seen in some post encephalitis cases. The tests have shown consistently wide scatter reflecting the difficulties in concentration, the short interest span, the erratic achievement of which teachers invariably complained to the parents. School progress has been based on other factors than achievement. As adolescents both have shown somewhat improved stability. In both cases it was felt that the test results adequately represented present functioning levels. Children 47G and 48G succeeded in making average scores as younger children, but the quality of their responses was consistently poor. These were the only children in this study whose legal adoption had been deferred a year since it was feared that their development might not prove to be normal in spite of an *IQ* of 100 on the Kuhlmann tests. Both have been unusually prone to severe accidents and illnesses including a skull fracture for 48G. They have been frail, thin children and on the basis of their physical health and interrupted schooling have attended special classes. It was felt that the tests adequately represented their present intellectual and academic ability. However, they have had splendid home training, are competent dancers and musicians, are socially poised, and thus give an impression of ability beyond the test scores.

Cases 81G and 23B are children in very simple home environments, where the intellectual stimulation is limited. In one home the father is dead, in the other extremely busy. Children of low average academic ability satisfy the aspiration levels of the parents. In neither case are the children encouraged to attain maturity or independence.

D. Relationships between Mental Development of Adopted Children and Characteristics of Their Foster Parents

1. *Occupational Level*

In the selection of foster homes all agencies give preference to families who not only have sufficient financial resources to assure adequate care for the child, but who show signs of culture, refinement, and intellectual and emotional understanding of the needs of children and the special problems of adoption.

The occupational level of foster families reflects this initial selection and has remained consistently well above the average for the general population. Table 8 shows the foster father and the true father occupations compared with the occupational distribution of the population as a whole, based on the 1930 census and classified according to Goodenough's seven-point scale (9). Figures for the 1940 census are not directly comparable because of differences in classification method, particularly in the clerical, sales, skilled, and slightly skilled occupations.

TABLE 8
DISTRIBUTIONS OF TRUE AND FOSTER FATHER OCCUPATIONS

Occupational classification	General U. S. population employed males, 1930	True fathers		Foster fathers	
	Per cent	Number	Per cent	Number	Per cent
I. Professional	3.1	2	2.7	14	14.0
II. Semiprofessional and managerial	5.2	3	4.1	17	17.0
III. Skilled trades	15.0	9	12.3	27	27.0
IV. Farmers	15.3	5	6.8	29	29.0
V. Semiskilled	30.6	10	13.7	8	8.0
VI. Slightly skilled	11.3	9	12.3	5	5.0
VII. Day laborers	19.5	35	48.0		
Number	100.0	73		100	
Mean	4.8	6.47		2.85	
Median	5	6		3	
Standard deviation	1.5	1.77		1.33	

In 1940 in the U. S. as a whole, 4.4 per cent of employed males were in professional occupations. In Iowa they constituted 3.7 per cent of the employed population while 14 per cent of the foster fathers were so employed. Although only 14 per cent of employed U. S. males are farm proprietors or managers, 29.5 per cent of Iowa men and 29 per cent of the foster fathers are so employed, thus farmers were adequately represented. In the U. S. approximately 17 per cent of men and in Iowa 19 per cent are unskilled laborers. None of the foster fathers, but 48 per cent of the natural fathers are so classified.

Further comparison between the figures for the foster parents, the general population, and the data for 73 true fathers for whom occupational information was available shows that the foster fathers are not only above the average of the population with a mean scale score of 2.85 as against 4.8 for the U. S. as a whole, but are conspicuously above the mean for the true fathers. The latter are, in addition, well below the mean for the total population with an average scale score of 6.47, equivalent to the status of an unskilled or very slightly skilled workman. The children whose natural parents, as a group, come from one extreme of the population were placed in foster homes representing the opposite extreme in occupational status.

Observation of the homes over the 13-year period showed that, although they were above the average in culture, resources, and financial security at the time the child was placed, they were, on the whole, even more prosperous at the end of the study. Only two fathers had been in military service, one as a professional man and one as a non-commissioned draftee. While some had benefited from high war wages, others on fixed incomes had been at a slight disadvantage. The general economic prosperity of 1945-47 was evident in most cases.

In a number of families rather serious changes in total family constellations had occurred. Among the 100 children five foster fathers and one foster mother had died by the time the children reached adolescence. None of the surviving foster parents had remarried and none seemed to plan to do so. No two families were affected by the bereavement in the same way. In four instances the foster mothers and the children seemed to be closer than they had been before. In only one case did this seem to have an undesirable emotional consequence for the child. In two instances there appeared to be increasing difficulty in relationships between the surviving foster parent and the children. In both cases there had been marked attachment to the deceased parent and a rather unsatisfactory plan for care and supervision or financial support after the death of the favored parent. Both children were becoming resentful, uncoöperative, and failing in school.

Serious illnesses, affecting family income and security, had occurred in six families. One foster mother, whose instability had been noticed in 1937, finally became psychotic and was hospitalized. The foster daughter of 15 has been keeping house very well for herself and the foster father. This is a family with one of the lowest cash incomes in the group but standards of cleanliness and order were very good. One father has been under periodic psychiatric treatment but has maintained a prosperous business. Another was absent from the home for several years as a wandering alcoholic, but has returned and is making a good adjustment. One father, suffering from a brain injury, and another father and a mother suffering from chronic heart disease have been invalids at home. There was no indication that the presence of these major health problems has had an unusual affect on the children. The general attitude was one of acceptance and understanding on the part of the children. The parents in good health were apt to be over anxious about insuring the continuance of education and economic and emotional security for the child.

In three of the 100 families the foster parents had been divorced. In all three instances the foster mothers had deserted and left the boys with the foster fathers. Two of the foster fathers had remarried and in both instances the foster mothers were sincerely interested in the children and showed more insight and intelligence than the original foster mothers had demonstrated during the earlier contacts. The boy whose father had not remarried was living with an elderly relative who disapproved of the foster father and the apparent exploitation of the boy's athletic skills. All three of these boys were having much difficulty in school and were having a generally difficult adolescence, but were neither delinquents nor seriously disturbed emotionally.

Relationships between the child's *IQ* and foster father's occupation are obscured because the personal qualities, the cultural opportunities and intellectual stimulation of the homes are not directly reflected by the occupational classification of the families. The opportunities of many of the farm (Class IV) and skilled trades (Class III) homes exceeded some of the teachers', physicians', and managerial homes (Classes I and II). The results, however, summarized in Table 9, show persistent slight differences in favor of homes in the upper three categories. Comparisons for all years except the first two are based on the 1916 Stanford-Binet. Since all available test scores were utilized and the number of cases at any year is small, detailed analysis is not attempted.

It can be concluded that, on the whole, children in homes in the higher occupational categories tend to have somewhat higher mean *IQ*'s at all ages. However, all the children, including those in homes of lesser occupational levels, are above the mean for the total population at all age levels where the number of cases is sufficient to warrant consideration.

2. *Education*

The distribution of educational attainment of the natural and foster parents is shown in Table 10. The average school attainment of the foster parents as recorded on the application record and verified in 1946 showed that mean and median attainment for the foster parents was high school graduation, with 15 per cent having completed college. According to the 1940 census figures the median education for native Iowans in a comparable age group (35-44 years of age in 1940) was 8.8 for males and 9.3 for females. In general, urban populations have an average of one more year of education than rural populations.

TABLE 9

COMPARISONS OF MEAN *IQ* AT AGES 1-16 FOR 100 CHILDREN PLACED IN UPPER THREE AND LOWER FOUR OCCUPATIONAL CATEGORIES

	Ages															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Mean *IQ* Upper 3	121	114	115	115	116	115	113	113	—	108	121	108	112	103	98	98
Mean *IQ* Lower 4	117	114	114	107	107	116	87	113	105	82	112	106	111	99	86	—
Number Upper 3	37	23	24	24	20	30	11	9	0	5	16	30	44	16	6	10
Number Lower 4	23	15	16	15	9	28	1	5	3	1	10	21	30	10	4	0
SD Upper 3	13.5	11.7	13.0	14.4	10.0	14.1	14.3	9.7	—	13.6	10.4	9.0	16.4	11.3	10.6	13.5
SD Lower 4	10.0	15.3	12.9	14.1	12.2	13.0	—	11.6	6.3	—	9.0	10.9	11.3	9.5	10.3	—

TABLE 10
DISTRIBUTION OF TRUE AND FOSTER PARENT EDUCATION

School attainment	True fathers No.	True fathers %	True mothers No.	True mothers %	Foster fathers No.	Foster fathers %	Foster mothers No.	Foster mothers %
20					3	3.0		
19							1	1.0
18					6	6.0		
17					2	2.0	1	1.0
16	2	3.4			10	10.0	14	14.0
15	1	1.7			7	7.0	9	9.0
14	2	3.4	2	2.2	2	2.0	10	10.0
13	3	5.0	6	6.5	14	14.0	16	16.0
12	15	25.4	24	26.0	16	16.0	18	18.0
11	7	11.8	9	9.8	3	3.0	5	5.0
10	3	5.0	7	7.6	6	6.0	8	8.0
9	3	5.0	9	9.8	5	5.0	3	3.0
8	13	22.0	23	25.0	23	23.0	9	9.0
7	5	8.5	8	8.7	2	2.0	4	4.0
6	2	3.4	2	2.2			1	1.0
5	2	3.4						
Less than 4			2	2.2	1	1.0	1	1.0
Unknown	41		8				1	
Number	59		92		100		100	
Mean	10.05		9.80		12.09		12.31	
Median	10.57		9.78		12.13		12.56	
SD	2.73		2.31		3.54		2.89	

The educational status of the true parents is significantly below that of the foster parents and is below the average of a comparable age group for the state. The 1940 census showed that native Iowans 25-34 years of age had a mean education of 10.2 for the males and 11.0 for the females. While the information on the education of foster parents is reasonably accurate, there is evidence that the education of the natural mother has been overstated by an average of one year (12, 26).

These data again show that while the education of the foster parents is superior to the average for their age and region, the natural parents' education is below the average for their age and region.

Correlations between foster parent education and child *IQ* on successive tests are summarized in Table 11.

Earlier reports on somewhat larger numbers of children showed a slight positive correlation between foster child *IQ* and foster parent education (24, 25, 26). In this array of correlations there is no discernible trend except a consistent lack of statistical relationship. Inspection of the original scatter diagrams confirms the lack of relationship. However, it should be pointed out that both the *IQ*'s and the educations represented here are confined to the upper segment of the total possible range. As long as the parents

TABLE 11

	Foster mother education	Foster father education
Child's Test I	—.03±.07	.05±.07
Child's Test II	+.04±.07	.03±.07
Child's Test III	.10±.07	.03±.07
Child's Test IV (1916)	.04±.07	.06±.07
Child's Test IV (1937)	.02±.07	.00±.07

are highly selected, and the children as a group also have a limited range of *IQ*'s and are in the upper half of the total population, it is not likely that repetition of similar studies will produce any more significant correlations. Increasing the number of cases may extend the range and sharpen the focus on what little difference exists. These figures are lower than correlations generally reported in the literature for both foster child-foster parent and own-child-parent correlations. However, in other cases the range for both distributions has been wider.

The only conclusions which may be drawn from these data are that the foster parents are above the average of their age and regional group in education and that the children in these homes are above the average in mental development. The differences between these adoptive parents in amount of formal education completed are not reflected in differences in intelligence between the children.

E. RELATIONSHIPS BETWEEN MENTAL DEVELOPMENT OF ADOPTED CHILDREN AND CHARACTERISTICS OF THEIR TRUE PARENTS

1. *Intelligence*

Intelligence test results were available for 63 of the true mothers. All were based on the 1916 Stanford-Binet except one Terman Group Test, two Otis, and one Wechsler-Bellevue. Since the scores on these tests were consistent with other evidence on the mental adequacy of the mothers, the scores were included. The tests were given by trained examiners, under ordinary testing conditions, usually after the mother had decided to release the baby for adoption. The release was not contingent on the mother's test score and examinations were not made when the mother was ill or obviously upset emotionally.

Table 12 shows the distribution of the true-mother *IQ*'s and child *IQ*'s at a mean age of 13.6 based on the 1916 Stanford-Binet. This test was selected since it offered the maximum available degree of comparability for parent and child intelligence test scores. The mean *IQ* of these children

TABLE 12
COMPARISON BETWEEN DISTRIBUTION OF *IQ*'S (1916 STANFORD-BINET) OF TRUE MOTHERS AND THEIR CHILDREN

IQ	Mothers No.	Mothers %	Children No.	Children %
130-134	—	—	2	3
125-129	1	1	6	10
120-124	—	—	6	10
115-119	—	—	7	11
110-114	2	3	6	10
105-109	5	8	7	11
100-104	5	8	10	16
95- 99	6	10	8	13
90- 94	8	13	3	5
85- 89	7	11	3	5
80- 84	5	8	1	1
75- 79	8	13	1	1
70- 74	5	8	2	3
65- 69	5	8	1	1
60- 64	4	6	—	—
55- 59	—	—	—	—
50- 54	2	3	—	—
Number	63		63	
Mean	85.7		106	
Median	86.3		107	
Standard Deviation	15.75		15.10	

on the 1937 revision is 10 points higher than on the 1916 revision. If a correction were to be made for the *IQ*'s of the mothers, as some investigators have suggested, the 1937 test scores of the children would be used, with the same relative difference between the two arrays of scores.

A difference of 20 points between the means of mothers and children is not only a statistically reliable difference (*CR* 9.2) but is also of considerable social consequence.

Previous analysis (26) showed that there was no difference between the mean *IQ*'s of children whose mothers had been examined and those whose mothers' *IQ*'s were unknown. This was confirmed by examination of the present data (see Appendix).

Relationships between mother-child pairs, with regard to *IQ*, expressed in terms of correlation coefficients on 63 cases, are summarized in Table 13.

TABLE 13

Test I	.00±.09
Test II	.28±.08*
Test III	.35±.07**
Test IV (1916)	.38±.07**
Test IV (1937)	.44±.07**

*Reliable at the 5 per cent level of confidence (17, p. 212).
**Reliable at the 1 per cent level of confidence (Ibid.).

It is apparent that the above tabulation contains more questions than it answers and can be the source of considerable controversy. Certain conclusions can be drawn, however. Among these are the following: Test scores of children secured during the first two years of life bear no statistical relationship to the scores of their mothers, nor, it should be noted, do they show a very high relationship to their own later scores ($r = .35$). By seven years of age a substantial correlation with true mother's *IQ* is reached which remains of the same magnitude in adolescence provided the 1916 Stanford-Binet test is used with both children and mothers. The correlation is still further increased if the 1937 revision of the Binet is used.

Many reasons can and have been advanced for the low correlation between infant tests and later measures which will not be reviewed here. There is considerable evidence for the position that as a group these children received maximal stimulation in infancy with optimum security and affection following placement at an average of three months of age. The quality and amount of this stimulation during early childhood seemed to have little relation to the foster family's educational and cultural status.

The available data which can be statistically used—occupational classification and formal education—are not sufficiently sensitive to be useful in measuring these less tangible differences in child rearing practises. This point is important for the interpretation of the correlations between the child's *IQ* and his mother's *IQ* because it is possible to throw the weight of interpretation in the direction of either genetic or environmental determinants. If the former point of view is accepted, then the mother's mental level at the time of her examination is considered to reflect her fundamental genetic constitution, and ignores the effects of whatever environmental deprivations or advantages may have influenced her own mental development. Thus it would be assumed that the children of brighter mothers would in turn be brighter than the children of less capable mothers regardless of the type of foster home in which they were placed. The increasing correlation might be interpreted to support this point of view, since the occupational differences between foster parents are not large. It is, however, inconsistent with the evidence that the children's *IQ*'s substantially exceed those of their mothers and that none of them are mentally defective even though a number of the mothers were institutional residents. The rôle of the unknown fathers adds to the complication although the evidence indicates that the fathers resembled their unwed partners in mental level and education (1).

If the so-called environmental point of view is accepted, then the question is raised whether the increasing correlation between child and true mother *IQ* possibly reflects the tendency to place the children of brighter mothers in the more outstanding foster homes, and the influence of these homes becomes increasingly prominent as the child grows older.

The question regarding selective placement can be approached in at least two ways. The first is an inspection of the relationships between such characteristics of the true and foster families as education and occupation. Using these crude measures, correlations of .24 between true mother *IQ* and foster parent education and .27 between true mother and foster parent education were found in this sample. Comparisons between true mother characteristics and foster father occupation for the present sampling are summarized in Table 14.

TABLE 14

	Foster father occupation					
	I	II	III	IV	V	VI
No. of foster fathers	14	17	27	29	2	5
Mean *IQ* of mothers of children in these homes	86	89	87	83	77	90
Number of cases	9	13	20	15	4	2
Mean education of mothers of children in these homes	10	10	10	8	8	8
Number of cases	12	16	28	25	9	2

It is apparent from both types of analyses that while a trend existed, selective placement, as evaluated by these measures was not consistently practiced.

Another approach to this problem of relationship is to examine the data for two contrasting groups of children. Selected for this purpose were: (*a*) Those children whose mothers were known to be mentally defective, with other evidence supporting the known *IQ* of under 70 ($N = 11$). (*b*) Those children whose mothers were above average in intelligence as measured by tests. Since there were only three cases above 110 *IQ*, the next five, in the 105-109 *IQ* range, were also included ($N = 8$).

Comparisons between the two groups are shown in Table 15. It is evident from the table that there is a marked difference between the intelligence and education of the true mothers of children in Groups (*a*) and (*b*). On the basis of education and occupation the foster parents of both groups are essentially similar, with perhaps a slight advantage for Group (*b*). On the first examination both groups of children were above average. By seven years of age a marked difference in mental level between the two groups is observable which persists into adolescence and is reflected by both the 1916 and 1937 Stanford-Binet tests. While children in Group (*a*) show average mental development as a group, the children in (*b*) show superior mental

TABLE 15

COMPARISONS BETWEEN CHILDREN OF MOTHERS OF INFERIOR AND OF ABOVE AVERAGE INTELLIGENCE

Case No.	True mother's *IQ*	True mother's Educ.	Foster mid-par. educ.	Foster father occup.	Child's *IQ*				
					Test I	Test II	Test III	Test IV	Test IV '37
					Group A				
8B	64	8	16	I	126	125	114	96	106
10B	64	11	8	III	125	109	96	87	100
18B	65	8	9	VI	114	102	112	122	118
53G	63	8	13	III	127	121	119	101	111
54G	67	9	12	III	116	113	113	91	102
58G	54	8	13	III	117	114	119	98	113
60G	66	8	10	V	105	109	90	105	115
67G	65	6	12	IV	110	111	114	95	103
70G	63	1	10	II	110	113	107	101	118
76G	67	7	15	I	109	92	87	74	84
82G	53	3	12	IV	81	87	80	66	74
Mean	63	7	12	3.2	113	109	105	96	104
Median	64	8	12	III	114	111	96	96	106
					Group B				
17B	128	12	12	III	120	128	148	127	145
22B	109	13	11	III	102	107	113	108	130
57G	109	13	16	III	99	126	139	132	130
61G	109	13	15	II	112	113	125	128	135
71G	113	12	19	II	128	112	114	114	122
72G	110	12	8	VI	116	92	105	103	104
73G	105	8	9	IV	125	111	129	110	131
87G	109	13	11	III	128	145	125	119	133
Mean	111	12	12.5	3.3	116	117	125	118	129
Median	109	12.5	11.5	III	117	112.5	125	117	130

F. Conclusions

Perhaps the most important contribution this study can make to the planning of future research is to point out the inadequacies of easily available data, and the necessity of formulating more clearly the various criteria used in the selection and assessment of the foster homes and the children. It is clear that the objective data used here, education and occupation, do not represent the real basis for selection and are not closely related to the child's mental development. Judging from the trend of correlations between mother's and child's *IQ*'s, one might conclude that a relationship exists which became increasingly apparent with age. This is complicated by the evidence of selective placement, yet without a parallel relationship between foster parent education and child *IQ*. This one set of figures must not be permitted to overshadow the more significant finding that the children are consistently and unmistakably superior to their natural parents and in fact, follow and improve upon the pattern of mental development found among own children in families like the foster families. What may be the salient features in the foster homes which have produced this development of the children, is only suggested in this study. It is inferred that maximum security, an environment rich in intellectual stimulation, a well balanced emotional relationship, intellectual agility on the part of the foster parents—all these and other factors contributed to the growth of the child. Unfortunately, there is still no scale for the measurement of these dynamic aspects of the foster home situation. The futility of arguments based on correlations involving measures of education and occupation applies to both sides of the discussion.

The conclusions which may be drawn from the material presented here suggest that:

1. The above average mental development of the children adopted in infancy has been maintained into early adolescence. There has been no large scale decline in *IQ* either for the group or for large segments of it, although certain children have shown either wide fluctuation or a steady decline or rise as compared with the first test results.

2. The educational or occupational data available for foster or natural parents in the typical social history record are not sufficient to predict the course of mental development of the children. Other factors, primarily emotional and personal, and probably located in the foster home, appear to have more significant influence in determining the mental growth of the children in this group.

3. The intellectual level of the children has remained consistently higher

than would have been predicted from the intellectual, educational, or socio-economic level of the true parents, and is equal to or surpasses the mental level of own children in environments similar to those which have been provided by the foster parents.

The implications for placing agencies justify a policy of early placement in adoptive homes offering emotional warmth and security in an above average educational and social setting.

TABLE 16

APPENDIX

Case number	Foster father's education	Foster father's occupation	Foster mother's education	True father's education	True father's occupation	True mother's education	True mother's *IQ*
1B	12	Farmer	12	8	Unknown	8	Unknown
2B	16	Minister	10	9	R.R. Man	9	100
3B	7	Electrician	10	Unknown	Unknown	7	71
4B	12	Gas Sta. Owner	13	13	Student	12	Unknown
5B	14	Farmer	14	Unknown	Truck Driver	12	89
6B	7	Farmer	7	11	Farm Hand	8	73
7B	12	Jeweler	16	Unknown	Unknown	8	Unknown
8B	18	H. S. Princ.	14	9	Unknown	8	64
9B	13	Accountant	12	13	Student	Unknown	Unknown
10B	8	RR Conductor	8	13	RR Wkr.	11	64
11B	13	Linotype Op.	13	7	Machinist	8	104
12B	18	Dentist	16	Unknown	Unknown	9	76
13B	8	Farmer	10	12	Road Labor	10	81
14B	8	Main.-Foreman	8	Unknown	Laborer	7	78
15B	13	Co-own. Store	14	15	Accountant	13	79
16B	15	Wholesale Sale	12	12	Unknown	8	Unknown
17B	12	Ins. Salesman	12	Unknown	Salesman	12	128
18B	8	RR Switchman	9	Unknown	Unknown	8	65
19B	12	Farmer	12	5	Farm Hand	9	71
20B	10	RR Mail Car.	12	Unknown	Elec. Power Plant	7	Unknown
21B	16	Dis. Mgr. Oil Co.	17	Unknown	Policeman	11	75
22B	9	Garage Mec.	13	12	Student	13	109
23B	10	Dept. St. Mgr.	12	Unknown	Constr. Lab.	12	Unknown
24B	15	Drug Salesman	16	Unknown	Laborer	Unknown	Unknown
25B	11	Garage Mec.	7	Unknown	Unknown	Unknown	Unknown

TABLE 16 (*continued*)

Case number	Foster father's education	Foster father's occupation	Foster mother's education	True father's education	True father's occupation	True mother's education	True mother's *IQ*
26B	8	Trucker	11	8	Sk. Laborer	6	Unknown
27B	12	Farmer	14	12	Greenhouse Wkr.	8	88
28B	8	Farmer	7	10	Cobbler	8	Unknown
29B	10	Farmer	13	16	Teacher	14	Unknown
30B	20	Physician	16	Unknown	Store Mgr.	10	Unknown
31B	9	Stoker Tender	11	Unknown	Farmer	Unknown	Unknown
32B	8	Farmer	14	6	Laborer	7	90
33B	20	Physician	15	12	Farmer	12	96
34B	15	Own. Feed St.	9	10	RR Worker	10	95
35B	18	Supt. Schools	15	12	Creamery Wk.	10	80
36B	18	Mayor & Store	8	Unknown	Clerk	12	Unknown
37B	12	Garage Mgr.	12	Unknown	Merchant	8	Unknown
38B	17	Farmer	16	11	Farm Labor	14	Unknown
39B	13	Dis. Mgr. T & T	13	Unknown	Unknown	8	102
40B	10	Farmer	6	10	Farm Labor	8	92
41G	8	Farmer	12	8	Odd Jobs	9	88
42G	8	Farmer	12	Unknown	Day Labor	12	100
43G	20	Physician	16	Unknown	Farm Labor	Unknown	Unknown
44G	13	Executive	14	14	Carpenter Hlpr.	12	91
45G	13	Executive	14	7	Carpenter Hlpr.	9	70
46G	13	Farmer	15	8	Laborer	11	84
47G	15	Auto Salesman	13	8	Farm Labor	8	78
48G	15	Auto Salesman	13	8	Farm Labor	8	78
49G	16	Editor	16	Unknown	Unknown	Unknown	Unknown
50G	16	Editor	16	12	Usher	12	87

TABLE 16 (*continued*)

Case number	Foster father's education	Foster father's occupation	Foster mother's education	True father's education	True father's occupation	True mother's education	True mother's *IQ*
51G	10	Butter Maker	10	7	Odd Jobs	7	Unknown
52G	13	Accountant	12	Unknown	Unknown	9	Unknown
53G	12	Grocer	15	Unknown	Unknown	8	63
54G	13	Service Mgr.	10	Unknown	Unknown	9	67
55G	13	Grocer	13	Unknown	Unknown	12	Unknown
56G	9	Engineer	15	5	Laborer	7	83
57G	16	OfficeClerk	16	Unknown	Unknown	13	109
58G	13	Produc. Clerk	13	8	Store Clerk	8	54
59G	8	Sander	12	12	Salesman	8	Unknown
60G	11	Syrup Maker	9	Unknown	Unknown	8	66
61G	16	Prop. Hatchery	13	12	Nursery Bus.	13	109
62G	8	Farmer	14	Unknown	Laborer	Unknown	Unknown
63G	15	Proprietor	12	Unknown	Unknown	12	88
64G	10	Window Trimmer	8	11	Unemployed	12	Unknown
65G	9	Garage Mec.	8	12	Farm Hand	12	95
66G	12	Farmer	13	6	Const. Gang	7	92
67G	8	Greenskeeper	15	Unknown	Unknown	6	65
68G	8	Ins. Salesman	12	14	Civil Eng.	12	Unknown
69G	12	Farmer	13	8	Foundry Wkr.	8	Unknown
70G	12	Ass't Emp. Mgr.	8	Unknown	Laborer	1	63
71G	18	Rl. Est. Broker	19	12	Laborer	12	113
72G	12	Section Foreman	4	8	Unknown	12	110
73G	8	Farmer	10	7	Unknown	8	105
74G	12	Office	16	Unknown	Farm Labor	12	96
75G	4	Farmer	12	Unknown	Unknown	8	78

TABLE 16 (*continued*)

Case number	Foster father's education	Foster father's occupation	Foster mother's education	True father's education	True father's occupation	True mother's education	True mother's *IQ*
76G	16	H. S. Teacher	14	8	Truck Driver	7	67
77G	13	Hardware	13	8	Farmer	13	Unknown
78G	16	Co. Engineer	16	11	Mechanic	9	80
79G	12	Farmer	16	12	Skilled Wkr.	11	Unknown
80G	16	H. S. Teacher	16	9	Unknown	11	Unknown
81G	8	Farmer	8	7	Truck Driver	11	Unknown
82G	11	Farmer	12	Unknown	Unknown	3	53
83G	8	Trucker	11	7	Laborer	11	Unknown
84G	12	Mailman	13	Unknown	Shoe Shop	8	74
85G	8	Cattle Trader	12	Unknown	Salesman	10	91
86G	13	Elec. Lineman	12	Unknown	Ins. Salesman	11	98
87G	9	Ret. Farmer	13	16	Eng. Student	13	109
88G	16	Veterinary	14	Unknown	Gas Station	12	92
89G	8	Poultry Sales	11	8	Laborer	10	91
90G	13	Auto Salesman	14	12	U. S. Navy	12	Unknown
91G	8	Road Grader	8	8	Auto Mechanic	8	Unknown
92G	17	Professional	16	11	Farmer	12	Unknown
93G	12	P. O. Clerk	11	12	R. Mail Carrier	12	88
94G	14	Executive	13	4	On relief	10	99
95G	8	R.R. Fireman	10	12	Truck Driver	11	90
96G	18	Supt. Schools	15	11	Farm Hand	12	104
97G	8	Hdwe. Salesman	12	Unknown	Farm Hand	9	Unknown
98G	8	Farmer	8	Unknown	Farm Hand	12	88
99G	12	Farmer	15	Unknown	Unknown	Unknown	Unknown
100G	15	Farmer	14	11	Mechanic	12	76

TABLE 17
APPENDIX (*continued*)

Case number	Age at examinations 1	2	3	4	*IQ* on examinations 1	2	3	4	4L
1B	1- 3	4- 1	6- 3	13- 3	121	114	115	105	115
2B	2- 5	4- 6	6- 5	13- 2	120	115	109	106	117
3B	1- 5	3- 8	6- 8	12- 7	131	109	113	95	106
4B	1- 7	4- 8	7-11	13-10	102	121	139	114	132
5B	1- 2	3- 4	6- 3	12- 3	126	115	113	90	99
6B	1- 4	3- 9	6- 2	13- 3	120	102	111	121	132
7B	1- 1	3- 8	6- 8	12-10	127	118	125	105	115
8B	1- 5	4- 5	6- 7	13- 8	126	125	114	96	106
9B	2- 5	4- 3	6- 9	13- 8	112	86	104	101	112
10B	2- 5	4- 9	7- 8	14- 1	125	109	96	87	100
11B	1- 6	4- 6	6- 7	13- 7	105	107	106	104	113
12B	0-11	2- 0	5- 3	11- 6	130	112	124	125	132
13B	1- 5	3- 4	6- 3	12- 5	107	120	109	115	118
14B	2- 5	4- 0	6- 4	13- 5	104	108	125	124	141
15B	1- 7	3-10	5-10	12- 8	120	117	114	109	114
16B	5- 7	7- 1	10- 5	16- 4	125	134	126	110	129
17B	2-11	4- 2	6- 3	13- 2	120	128	148	127	145
18B	2- 1	4- 3	6- 8	13- 9	114	102	112	122	118
19B	1- 5	3- 8	6- 7	12-10	122	100	128	119	120
20B	1- 7	3-10	6- 0	13- 0	120	113	114	101	113
21B	3- 1	5- 7	10- 7	16- 2	119	101	102	97	106
22B	3- 7	5- 7	8-10	15- 0	102	107	113	108	130
23B	3- 3	6- 4	8-10	15- 7	99	100	103	81	94
24B	3- 3	5- 2	8- 6	14- 5	118	113	122	109	123
25B	2- 6	4- 1	6- 6	13- 6	117	131	126	124	139
26B	1- 8	2- 8	5- 7	11- 7	134	130	115	100	111
27B	3- 6	5- 3	8- 3	14- 3	133	121	115	97	118
28B	1- 8	4- 4	6- 6	13- 6	103	87	103	110	121
29B	1- 7	3- 9	6- 8	12-10	105	116	125	118	122
30B	1- 1	4-11	6- 5	12- 5	141	95	105	98	106
31B	1-11	4- 9	8- 2	14- 1	99	95	92	88	104
32B	3- 2	5- 3	8- 2	14- 4	95	89	115	97	116
33B	2- 7	3-11	6-10	13- 9	82	106	105	105	109
34B	1- 7	4-11	7-10	13- 9	136	115	118	104	112
35B	3- 2	6- 1	8- 6	15- 6	104	107	107	96	113
36B	2- 0	4- 0	6- 3	13- 2	134	133	128	124	137
37B	1- 3	4- 7	6-10	13- 8	119	98	93	109	118
38B	2- 2	3- 9	6- 8	12-11	97	98	106	106	107
39B	1- 4	5- 8	8- 6	14- 5	119	103	101	86	101
40B	1- 7	3- 1	6- 0	12- 3	116	121	119	109	114
41G	4- 1	6- 9	9- 0	15- 9	90	94	95	77	90
42G	1- 4	4- 1	6- 3	13- 1	104	114	104	100	108
43G	2- 2	4- 2	7- 5	13- 2	125	124	116	127	134
44G	3- 0	4- 5	7- 8	13-10	99	102	128	126	142
45G	1- 4	2-10	6- 1	12- 3	135	112	118	118	124

TABLE 17 (*continued*)

Case number	Age at examinations 1	2	3	4	*IQ* on examinations 1	2	3	4	4L
46G	1- 3	2- 4	5- 2	11- 5	125	108	116	101	105
47G	1- 6	2- 6	6- 5	13- 5	102	90	99	73	78
48G	1- 6	2- 6	6- 5	13- 5	108	90	86	80	82
49G	3- 9	5-11	8-10	14- 9	116	115	130	116	138
50G	1- 3	3- 4	6- 3	12- 2	113	97	101	109	115
51G	2- 2	5- 1	8- 5	14- 5	115	108	112	89	99
52G	0-11	2- 8	5- 2	12- 1	135	113	97	107	102
53G	3- 5	5- 3	8- 6	14- 6	127	121	119	101	111
54G	1- 9	3-10	6- 8	12- 9	116	113	113	91	102
55G	2- 1	3- 9	6- 0	13- 0	135	142	142	123	131
56G	1- 6	4- 6	7- 9	13- 8	101	93	99	88	92
57G	1- 2	2- 7	5- 6	11- 8	99	126	139	132	130
58G	3-10	5-10	8- 0	14-11	117	114	119	98	113
59G	2- 5	4- 2	6- 8	13- 4	99	108	105	117	120
60G	1- 3	2- 3	5- 2	11- 4	105	109	90	105	115
61G	1- 3	2- 5	5- 4	11- 4	112	113	125	128	135
62G	6- 9	9- 4	12- 4	18- 6	112	106	101	110	133
63G	2- 4	4- 4	6- 4	13- 2	114	138	124	122	124
64G	2- 8	4- 7	6- 8	13- 5	120	120	120	123	129
65G	1- 3	3- 7	5-10	12- 9	140	130	126	118	125
66G	1- 1	2- 4	5- 3	11- 3	120	113	114	127	127
67G	3- 2	6- 2	9- 3	15- 0	110	111	114	95	103
68G	1-11	4- 0	6- 2	13- 2	151	146	132	141	152
69G	1- 6	4- 4	6- 5	13- 2	111	104	106	111	115
70G	4-10	7- 2	10- 2	16- 1	110	113	107	101	118
71G	1- 1	2- 4	5- 4	11- 4	128	112	114	114	122
72G	1- 6	4- 4	6- 6	13- 6	116	92	105	103	104
73G	2- 5	5-10	8- 9	14- 8	125	111	129	110	131
74G	1- 8	3-10	6- 1	13- 1	128	139	118	115	130
75G	2- 5	4- 5	6- 7	13- 7	138	125	139	116	123
76G	4- 2	7- 3	10- 6	16- 6	109	92	87	74	84
77G	1- 4	3- 1	6- 1	12- 3	136	130	141	121	130
78G	0-11	2- 0	5- 0	11- 3	109	112	127	131	139
79G	1- 6	4- 3	6- 1	13- 4	114	133	129	113	126
80G	2- 6	3-11	6- 4	13- 4	115	111	122	119	126
81G	2- 7	4- 3	6- 6	13- 6	89	94	95	79	80
82G	5- 7	7-10	10- 7	17- 2	81	87	80	66	74
83G	1-11	2-11	5-10	11-10	117	107	123	108	111
84G	2- 5	4- 2	6- 7	13- 8	121	132	132	113	120
85G	1- 6	3- 2	6- 3	12- 5	120	105	131	123	137
86G	1- 2	3- 1	6- 4	12- 6	142	135	147	123	137
87G	1- 3	3- 4	6- 3	12- 6	128	145	125	119	133
88G	2- 2	4- 7	7-11	14- 1	115	113	113	112	122
89G	1- 1	2- 8	4-11	11-10	105	130	115	111	123
90G	4- 9	7- 4	10- 3	16- 3	105	102	115	91	112

TABLE 17 (*continued*)

Case number	Age at examinations 1	2	3	4	*IQ* on examinations 1	2	3	4	4L
91G	1- 4	3- 8	6- 8	12- 9	127	100	103	90	101
92G	2- 6	3- 5	6- 6	12- 3	126	117	110	107	106
93G	1- 4	3- 5	5- 7	12- 4	112	107	110	103	116
94G	1- 1	3- 5	6- 5	12- 4	117	112	109	101	111
95G	1- 4	2- 4	5- 2	11- 5	122	127	129	126	143
96G	1- 3	4- 2	6- 7	13- 7	108	124	116	113	121
97G	2- 0	5- 1	8- 1	14- 2	113	105	109	97	104
98G	1- 3	3- 7	6- 3	12-11	122	112	119	94	106
99G	1- 4	2- 4	4- 7	11-10	128	102	113	117	123
100G	1- 6	3- 9	6- 8	12- 7	122	107	128	101	111

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BOOKS

The *Journal of Genetic Psychology*, the *Journal of General Psychology*, and the *Journal of Social Psychology*, will buy competent reviews at not less than $2 per printed page and not more than $3 per printed page, but not more than $15.00 for a single review.

Conditions. Only those books that are listed below in this section are eligible for such reviews. In general, any book so listed contains one or more of the following traits: (*a*) Makes an important theoretical contribution; (*b*) consists largely of original experimental research; (*c*) has a creative or revolutionary influence in some special field or the entire field of psychology; (*d*) presents important techniques.

The books are listed approximately in order of receipt, and cover a period of not more than three years. A reviewer must possess the Ph.D. degree or its equal in training and experience.

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CRITICAL REVIEWS OF RECENT BOOKS

The Journal of Genetic Psychology, 1949, **75**, 129-135.

(Halstead, W. Brain and Intelligence: A Quantitative Study of the Frontal Lobes. Chicago: Univ. Chicago Press, 1947. Pp. 206.)

REVIEWED BY LEE J. CRONBACH

While refinement of statistical approaches has led to increasing knowledge about the external manifestations of intelligence, there has been little corresponding disclosure of the underlying nature of intelligence. The physiological characteristics of the intelligent organism have been little clarified since Lashley's significant findings on the learning of brain-operated rats. Attempts to find out, from comparable studies of people, how the human body makes intelligent behavior possible have lagged, for reasons partly indicated in the following comment by Stoddard (1, p. 57):

> The mental tests reported for most patients in the operating room are unsuitable. Frequently they are not well described. A subtle operative technique on the part of a distinguished surgeon may be coupled with the crudest kind of clinical observation of adult mental behavior. This behavior is poorly measured by tests, particularly under conditions of convalescence from a major operation. In summing up such data, it is not enough to ask what is the effect upon general mental level, if that can be ascertained; we ask also what kind of behavior is affected, for example, as between concrete and abstract. . . . The final questions for our purposes cover the implications of surgical operations ("insults" to nervous tissues) for the meaning of intelligence and its development within the individual.

In the research program which Halstead reports in *Brain and Intelligence*, many of these difficulties have been faced and overcome. This first assembled presentation of findings which he began to collect 10 years ago and is continuing to extend, promises that from his work will come important new questions and some important answers about the brain. Halstead enters his research with major advantages over previous workers. He is able to draw on the large number of brain-damaged cases resulting from the war, and from the large number whose brains have been altered by the recently popularized lobotomy technique. He is associated with a hospital where the competence and scientific observation of the surgeons is beyond question. He has been able to test his subjects after the initial trauma of the operation itself has worn off, and he has chosen and developed a collection of precise tests which give an informative map of the qualitative effects of brain damage.

The volume seeks to perform several services. There is, first, an insightful review of the major points of view regarding intelligence and of the controversies within the fields of psychometrics, clinical practice, and neurophysiology. This crystallization will be generally useful, the more so because Halstead relates these views to each other. He shows, for example, the kinship of Lashley's theory of brain functioning and the psychometrists's *g*. Halstead then introduces his procedures, many of which are described in enough detail to be of interest to others seeking to duplicate his techniques. A considerable body of data about his subjects is presented, data which probably will permit other students of neuroanatomy to make detailed analyses of significant questions. The greatest portion of the book presents hypotheses about the nature of biological intelligence, based in part on the data analyzed, in part on other studies he reviews, and in part on imaginative interpretation.

This volume is far from a stereotyped report of a set of observations. For one thing, the book is liberally illustrated, with informative and well-printed halftones and drawings of apparatus, brain-lesion charts, and schematic explanations. The textual content is remarkable for its sweeping inclusiveness. Halstead has no qualms in stretching from consciousness in philosophy, to the performance of violinists under oxygen deprivation, to the *EEG* as an index of tension—all in the same brief chapter! So generous a serving of materials places many ideas in juxtaposition which the psychologist rarely sees in the same gestalt, and as a result Halstead's pages provoke thought to a rare degree. This virtue has a concomitant defect; the book is extremely hard to follow. The organization is unsatisfactory, and facts needed to understand one page are to be found sprinkled through the later pages of the book, or sometimes not to be found.

The treatment of important ideas is often sketchy; the 149 pages Halstead has written are more than his data alone require, and fewer than enough to carry his associated ideas. In many cases, analogies are employed which are either far-fetched, or so ingenious a restructuring that one does not follow his thought. As an example, consider this comment on abstraction (and he does mean such a factor as the Henmon-Nelson test taps):

> Biologically speaking, this ability factor is an old one indeed. It is a vital property of the individual cell, perhaps nowhere more strikingly demonstrated than in the phenomena of mitosis. But, even before the cell, it is reflected in the homogeneous principles of organization of certain crystal forms (pp. 96-7).

Since he has just previously equated "abstraction" to "combining on the basis of a criterion," this may be an instance where he has been carried away by a semantic parallel.

While the specific findings about the effects of certain brain ablations may in the long run prove to be the major contributions of this work, Halstead intends it to introduce a set of hypotheses about the nature of intelligence itself. This theory of "biological intelligence" must therefore be given close scrutiny. If Halstead's position is a sound one it will have major influence on psychological thinking, test design, and clinical practice.

The crucial point for Halstead, as for many others concerned about the brain as an adaptive organ, is that one can remove a good deal of the brain without lowering test *IQ*. Similarly, anoxia impairs functioning long before a decline in *IQ* is registered. Halstead therefore hopes that other tests may be found which will reveal loss of biological intelligence. From his tests he isolates four factors, in terms of which he describes and theorizes about adaptive behavior. The following quotation will show that his position is a strong challenge to convention in this area:

> If we examine the content of the Stanford-Binet test from the standpoint of our basic factors (*C*, *P*, *A*, *D*), we find that its content makes substantial demands on *C* (central integrative field factor), much less demand on *A* (factor of abstraction) and *P* (power factor), and a substantial demand on our *D* factor (specific abilities). . . . The fact that the scale shows a moderately high correlation with ability to do secondary-school work, for example, validates neither the scale as a measure of intelligence nor, for that matter, the schoolwork commonly selected as worthy tasks. One could probably arrange the optical or temperature components, for example, of school environments in such a way that quite different indicators would become "valid" in predicting performance—if, indeed, this has not already been demonstrated. Whether biological intelligence is a critical factor at all in successful performance of schoolwork or in setting the tasks for it remains to be demonstrated. Certainly there is some reason to suspect that the school situation may provide a mass medium for impressing neurotic modes of adaptation—the polar extreme of biological intelligence—upon the general population.

The evidence does not seem adequate to support Halstead's view. While both the Stanford-Binet and present educational methods may justly be criticized for their limitations, there are no data in this study which afford a basis for improvement in either. If Halstead is dissatisfied with older mental tests, his own measuring devices are unlikely to be better. For he points out that the Henmon-Nelson test is quite comparable to the Binet, in terms of the functions it taps: yet the Henmon-Nelson test has considerable communality with the tests Halstead accepts as indices of biological intelligence. At the most, the finding that the Binet does not reflect brain damage implies that supplementary tests should still be sought.

The heart of Halstead's theory and of his presentation in this volume is a factorial analysis. If he is correct that there are four significant factors of mentality, unrecognized as such heretofore, these factors would become important for many investigators. Unfortunately, the factorial study around which the surgical study is oriented is open to severe criticism. It is important to make the issues very explicit, since Halstead's procedures are promising and the continuation of his studies can be helpful if the interpretation is more soundly oriented. The basic difficulty is that in a factor analysis the investigator has many chances to impose judgment on his data, and unless those judgments are beyond question, the findings may also be suspect. The following judgments are crucial in this study: choice of tests to be factored, rotation of axes, and interpretation of the factors.

What factors Halstead finds in biological intelligence depends on what tests he puts into his battery. The basis for test selection is ambiguous, since biological intelligence is nowhere defined. He prefers that this definition be inferred from the tests which measure it. But the tests were chosen in part for practicability, and in part because they "seemed likely to reflect some component of biological intelligence." When we go behind this circularity, it appears that he means, but nowhere states, that "biological intelligence is that which is reduced by frontal-lobe injury." He began his work with 26 diversified tests. Ten quantitative tests which discriminated lobectomies from controls are retained (no data on the differentiating power of the others being reported). These 10 tests are used in an impairment index. Eight of these tests, plus three others, are used in the factorial analysis. This selection procedure is unexplained. Flicker fusion is kept in the battery, but the Seashore tonal tests, which also discriminate the brain-injured, are not retained. The absence of an explicit rationale for test selection is reminiscent of the days of Galton, when investigators tried one test after another almost at random, to see what they might reveal about individual differences. The tests employed are acceptable, but there must be other performances that would be just as important as tapping rate, peripheral vision, and flicker fusion. In any case, 13 tests are too few to be the basis for mapping a domain which encompasses attention, sensory capacity, adaptation in simple performance, ability to learn, and speed of reaction.

Halstead asked Thurstone to make the factorization reported "blindly," without knowledge of the tests themselves. But Thurstone himself indicates

(2, pp. 331, 337) that rotation should be based on psychological characteristics of the tests. Because the rotation reported is the basis on which the factors were identified, the reviewer has attempted to make a better rotation, using the knowledge about the tests which was not available to Thurstone. The new structure given in Table 1 does not differ grossly from that published, but is perhaps more interpretable. The new structure is at least as simple as the original, and more tests have loadings on just one factor. Halstead's data are not adequate to permit a confident unique rotation and factorial interpretation. The correlations are based on 50 cases, and correlations near .30 for such a sample are quite unreliable. The communalities of the tests are generally low, which means that much of the variance of each test is unique and not accounted for in the common factors. In other words, when we center attention on the common factors, the aspect of behavior that accounts for the decline of performance on a test after brain injury may be poured down the drain with the neglected unique factors.

TABLE 1
FACTOR LOADINGS OF HALSTEAD'S TESTS
(Loadings under .20 omitted)

Tests	Analysis by Thurstone (blind)				Rotation by reviewer			
	C	*A*	*P*	*D*	*C*	*A*	*P*	*D*
1. Carl Hollow Square	.25	.45				.45		
2. Halstead Category	.5	.6				.65		
3. Flicker fusion			.5				.5	
4. Seguin formboard, presented nonvisually				.6				.5
5. Recall from 4: incidental learning		.7	.4		—.4	.6	.4	
6. Recall from 4, more difficult test		.3	.25			.3	.2	
9. Henmon-Nelson	.6	.3				.4	.3	
13. Perception of speech sounds	.5				.5			
14. Tapping rate	.4		.25		.4			
16. Memory for time interval	.4				.3			
17. Rapid form perception	.4		.6		.3		.6	
18. Rapid color perception (simultaneous with 17)	.4		.6		.3		.5	
19. Peripheral vision in brief exposure (simultaneous with 17, 18)				.5				.5

Looking at the suggested interpretation of the factors, there can be little disagreement with the designation of *A* as "abstraction," or perhaps merely *g*. The new rotation throws more of the variance of the Category test (which is an excellent measure of intelligence as Binet defined it) into the second column. The remaining positive loadings are equally consistent with the notion of *A* as general intelligence (ability to learn, adaptability, reasoning). The first factor *C* is found in a thoroughly heterogeneous group of tests, by either rotation. The defining tests, 13, 14, and 16, could scarcely be less alike in apparent content than they are. Halstead calls this factor by the unclear name "central integrative field." This seems to mean that high *C* represents alertness to a wide range of possible perceptions, and might have such synonyms as receptiveness, recognition of cues, sensitivity, and range of information. A simpler explanation may be that the tests loaded with *C* have a common element of effort, concentration, immediate motivation, or purposiveness. In the new rotation, No. 5 takes on a negative loading; it is a measure of *incidental* learning, tested without advance warning. The difference between 19 and 17-18 may be that the subject who concentrates strongly on foveal stimuli is less likely to perceive the peripheral simultaneously. Certainly, *C* cannot be interpreted confidently without further data.

P, the power factor, is a remarkable suggestion. Just one test, flicker fusion, has loadings on this factor only. The two tests with next highest loadings are two aspects of a single visual performance. Just what is the factor being measured cannot be explained from the correlational data, but it may be a very fundamental and significant characteristic. Halstead shows that flicker fusion relates to the *EEG*, and suggests that it is an indicator of the brain's ability as an electronic system to handle signals in rapid succession without an overload. Flicker-fusion performance declines with anoxia and brain damage, and in the undamaged brain fluctuates over long and short cycles allegedly having some correspondence to work efficiency. It is premature to consider the power factor to be identified, on the basis of the few loadings found, but Halstead makes a convincing case that something is revealed by the flicker-fusion test which is worth much further study. Whether this index is "biological intelligence" or not, it may be a valuable diagnostic indicator and research tool.

The *D* factor is established on the basis of only a single correlation ($r_{4.19} = .363$). The location of such an axis is quite untrustworthy (cf. Thurstone, 1, pp. 334-340), and the loadings of the tests might be much different in a new sample, or in a new battery of tests. It appears best to dismiss the *D* factor until new evidence is secured. Halstead chooses instead to interpret it as a directing factor, which permits one to exteriorize intelligence through special, effector abilities. This hypothesis is contrary to previous concepts of effector abilities, and if one must interpret *D*, there is some basis for thinking of it as an ability to resist distraction. Both Tests 4 and 19 demand performing a task under unfamiliar, disorganizing, annoying conditions.

In summary, it appears that Halstead's factors are not rooted in sufficient evidence. Before they can be used as operational concepts, and a theory of intelligence built upon them, there must be more factorial studies with more tests and more cases, until each axis is determined with little ambiguity. There may be some significance to the tentative factor *C*, but its present identification is unsatisfactory. The flicker-fusion test appears likely to be important, but it might be wiser to think conservatively of it as an isolated indicator, rather than a "power factor," until more evidence is in hand.

Halstead mentions most of the limitations of factor analysis and of his data, at some place in his report. But the extent to which he has been willing to pile interpretation upon his data suggests that he did not completely recognize how damaging these limitations are. Halstead warns the reader that he is dealing with exploration, speculation, and analogy. These cautions could scarcely be given too emphatically.

Halstead's book is significant. His data are gathered with admirable technique and imagination. Hypotheses are gathered from stars and spun from cobwebs, but many of them have an appeal that should lead to long and rewarding research. The possibilities of the brain-damaged patient as a subject are important, and Halstead will be a guide to studies of this resource. If all the speculations are rejected, and most of the book is speculative, there remains a major body of facts and significant summaries of concepts that must not be ignored.

Biological intelligence has not here been clarified. It is still undefined, unmapped, and probably largely untested. But new light has been shed on what brain damage does to performance, and that is a welcome contribution.

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The Journal of Genetic Psychology, 1949, **75**, 137-144.

(Terman, L. M., & Oden, M. H. The Gifted Child Grows Up. Stanford: Stanford Univ. Press, 1947. Pp. 448.)

REVIEWED BY FRANK T. WILSON

The Gifted Child Grows Up is the exciting title of the fourth volume in the monumental *Genetic Studies of Genius* presented by Professors Terman and Oden and their associates at Stanford University and the coöperative group of subjects first studied in 1921 now, as reported in this volume, 25 years older. Have these men and women stood the test of years? Have they fulfilled the "promise of youth?" The answer in general is, "Yes, decidedly so." The answer is, also, "within the limits of human nature," for not all reached the high goals hoped for. Apparently, factors of circumstance combined, perhaps, with others of deep inner nature, bore upon some of these gifted individuals, just as markingly as they do on the rest of us. One cannot but wonder if that unhappy outcome was necessarily in the cards fate dealt out to them..

The rare opportunity of following individuals for 25 years has contributed to the monumental character of the Terman series. Few, if any, longitudinal studies covering such a long period of time and with such a large number of subjects, have been made in the field of social studies, certainly none with the competence, care, and thoroughness of this one. And, as the authors say: "The investigation is now only at its half-way point" (p. 379). Therewith they suggest lines of investigation for the next 25 years: estimate more fully "the ultimate contribution of the group to science, scholarship, literature, and social welfare," and "its ultimate fertility, longevity, insanity rate, and divorce incidence," test "all of the second generation by the Stanford-Binet Scale," also "even the third and fourth generation," give the original subjects "more thorough tests of general intelligence," if possible "at five- or ten-year intervals," study in them "the problem of mental aging in which the well-documented case histories will contribute extraordinarily valuable data on marital happiness or maladjustment," secure "psychiatric examinations" for all members of the original group, see if for them the Sheldon method as to somatotypes holds, "so that personality data and case histories could be correlated with body build" (pp. 379-380). "Our gifted group because of the detailed case histories available for the individual subjects, is probably capable of throwing more light on this problem than any other group in the world" (p. 380).

This "ambitious" program "is in fact minimal, rather than ideal" (p. 380). On such a rich basis of record already at hand these and other investigations seem certainly to merit high position on priority lists for research grants. Many of us wish to Dr. Terman and his collaborators 25 years and more of borrowed time to share in such studies, and for ourselves a similar elixir so that we, too, might know the full course of life of the individuals so far engagingly revealed.

The general plan of the book gives first a brief historical account of the beginnings of the study, which involved 1,528 children sifted out of "a school population of about a quarter-million," in California, and all of whom fell within the upper 1 per cent of mental ability. A résumé of the nature and findings of this first study is given in Chapters I to V. The complete account of this study is presented in Volume I of the Genetic Studies of Genius, *Mental and Physical Traits of a Thousand Gifted Children*. Another résumé of a follow-up study in 1927 appears in Chapter VI. "Perhaps the most important outcome of the 1927-28 follow-up was the fact that the composite portrait of the group had changed only in minor respects in six years. As a whole, the group was still highly superior intellectually, for the most part within the top 1 or 2 per cent of the generality" (p. 64). The full account of this study appears in Volume III, *The Promise of Youth*.

Chapter VII describes follow-up investigations made in 1936, 1940, and 1945. Nearly all of the information gathered in these follow-up studies was obtained by the use of information blanks, rating devices, and interviews. Most of it was obtained by mail. The percentages of returns sent in by the subjects known to be living when solicited for information in the last studies was the answer to the prayers of all mail survey enthusiasts: in 1940, 96 per cent "actively coöperating"; in 1945-46, 95.3 per cent "supplied the information called for" (p. 77). This "almost incredible amount of coöperation" although presumably motivated in part by loyalty to Dr. Terman, might well be judged one of the characteristics of gifted individuals indicative, perhaps, of a degree of socialization not commonly found "in the generality."

Chapters VIII to XXV discuss the findings of the complete study of the subjects from 1921 to 1946, with particular emphasis upon the latest data obtained. A considerable variety of chapter headings indicates the wide scope of these concerns, including such matters as mortality, health, adjustment, interests, marriage, war records and many others. The final chapter is headed, "Looking Backward and Forward." A list of 75 cited references and over two pages of others follow the last chapter, and in a large appendix the reproductions are given of most of the instruments used for gathering data in the 1936, 1940, and 1945 surveys. These documents may well become standard forms for securing information in regard to gifted children in other investigations in the field. They were most carefully and expertly devised. Much needed additional valid and reliable data regarding superior individuals could thus be obtained by other workers, who might make use of them at great saving of time and probably of error.

Questions may be raised as to the sampling of giftedness originally made by Terman and his co-workers, of the statistical sufficiency of treatment of some of the data, e.g., the use of critical ratios, rather than the significance of terms or the comparison of the whole of a population with a selected part of it, and of the highly subjective nature of most of the data comprising most of the last three follow-up studies. These criticisms seem academic, however, in the light of the accumulation of reasonableness the 25 years of results have produced. Not that a summation of errors makes for truth but that the accumulation of evidence clarifies what at one stage may not be clear. The individuals lived up to their early classification as mentally superior. Their mental superiority reflected itself in general in areas where mental ability counts appreciably, in school work, occupation, and in many other human relationships.

Most of the findings of the several follow-up studies verify conclusions tentatively made in the first volume, and the promise indicated by the data of volume three. The 1,434 living individuals of the original 1,528 who responded were found, after 25 years, to maintain their physical, mental, and personal superiority: "in vocational achievement . . . well above the average for college graduates," "show a normal or below-normal incidence of serious personality maladjustment, insanity, delinquency, alcoholism, and homosexuality," "the incidence of marriage (to 1945) is above that for the generality of college graduates of comparable age in the United States," "marital adjustment . . . is equal or superior to that found in groups less highly selected for intelligence," "offspring . . . show almost exactly the same degree of filial regression as is predicted by Galton's law" (p. 378).

There is evidence given in this volume, however, which is contrary to two widely held opinions regarding gifted individuals. One of these hypotheses was proposed by the late Leta Hollingworth, and supported by others, as possibly a general problem, the personality adjustment difficulties of the highly gifted. In Chapter XXI, "Subjects of *IQ* 170 or Above," the authors specify particulars regarding 45 men and 29 women so classified (the 1921-23 subjects were 857 boys and 671 girls) "to discover how (they) . . .

differed from the gifted group as a whole" (p. 294). "The results . . . were more often negative than positive." "The ratings on nervous symptoms and mental adjustments as of 1922, 1928, and 1940 were almost identical for the high group and for the total group with one exception: in 1940 a somewhat smaller proportion of women in the high group ($N = 32$ in this particular) than in the total group were rated as "satisfactory." Terman gives a critical ratio for this difference of 2.5, using McNemar's formula, cited in a footnote to page 284. This concession of a point on the basis, frankly, of rather slim data and the stretching of statistical terms, seem not convincing, especially in view of the clearly negative evidence of the other comparative data presented on this question.

In regard to "social adjustment," the analysis shown in a table on page 28, likewise indicates no clear trend toward maladjustment.

> Except for the ratings of 1928, the data give little support to the belief that children of extremely high *IQ* develop a greater amount of social maladjustment than do bright children of considerably lower *IQ*. That the ratings secured in 1928 were somewhat unfavorable to the high groups may possibly mean that for a period around the middle teens the child of *IQ* 170 or above is especially likely to show some maladjustment. If this is true, the condition is one which appears to correct itself later" (p. 287).

Discussing this matter further the authors say:

> That the child of very high *IQ* faces a more difficult problem in social adjustment than does the less precocious child cannot be denied. Consider, for example, the seven-year-old boy in our group whose mental age at the time was 13 years, and whose favorite reading was Gibbon's *Decline and Fall of the Roman Empire!* A large part of this boy's vocabulary was utterly unintelligible to the average boy of his age; it was almost as though he spoke a different language. For a time he had difficulties galore in social adjustment, but in 10 years he seemed to have won out over all of them. Many other subjects in our group have had a similar history. The point is that, although children of this type are faced by difficult problems of adjustment, they have very superior intelligence with which to meet them. "Social" intelligence correlates positively rather than negatively with "verbal" intelligence. Although among gifted children and also among historical geniuses there are individual cases of what might be called social imbecility, these are rare exceptions to the rule (pp. 287-88).

Chapter XX takes up "The Problem of Acceleration." This old administrative device for partially meeting the individual needs of gifted children seems at present writing to be reposing somewhat disgracefully in the educational dog-house, although more school systems than some suppose are relying heavily upon the sophistically discredited practice.

An elaborate analysis and comparison of data regarding three groups is presented in this chapter. Group I comprised 36 men and 26 women who had been accelerated two to four years. Group II had 181 men and 151 women advanced from one to two years; and Group III, 568 men and 430 women, had zero to one year acceleration. Six areas of appraisal were covered: intelligence, educational history, vocational status and avocational interests, social adjustment, marital status, and physical and mental health. The data bearing upon this problem are complex, to say the least. To begin with, acceleration, while tending to be used most heavily with the most intelligent (according to the childhood Binet *IQ*'s Groups I and II were significantly superior to Group III), other factors were operative, so that not all the very high *IQ* children were accelerated.

Data showing comparative educational achievement in terms of number graduating from college, age at college graduation, average *B* grade or better, graduation with honors, years of graduate work, earning 15 or more recommending high school units, and mean achievement quotients (Table 79, pp. 269-70) indicated records by accelerated individuals as good as or better than by non-accelerated. The former, it must be remembered, were younger when in school and "skipped" instructional contributions to their knowledge and skills to a greater or lesser degree.

Eight measures of social adjustment were applied to the three groups. "Our conclusion from the evidence . . . is that the influence of school acceleration in causing social maladjustment has been greatly exaggerated" (p. 275).

As to marriage:

> "The differences in the marriage rate are not statistically reliable. . . . Separations and divorces occurred less often among the highly accelerated." "The mean age at marriage was appreciably lower for the accelerated group (1.3 years, each sex, for Group I compared with Group III). This trend is significant from the point of view of eugenics" (p. 276).

Seven comparisons as to physical and mental health gave "no support to the fairly wide-spread opinion that rapid promotion in school is likely to be detrimental to physical and mental health" (p. 279).

In concluding the chapter the authors refer to Noel Keys' monograph on *The Under Age Student In High School and College,* "Whose findings support the conclusions of this chapter at almost every point" (p. 281).

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Finally:

> It is our opinion that children of 135 *IQ* or higher should be promoted sufficiently to permit college entrance by the age of 17 at latest, and that a majority in this group would be better off to enter at 16. Acceleration to this extent is especially desirable for those who plan to complete two or more years of graduate study in preparation for a professional career" (p. 281).

Chapter XXII on "Subjects of Jewish Descent" gives many comparisons with non-Jewish subjects, showing among other things that the 152 Jewish individuals in the gifted group revealed no reliable differences in *IQ*, scholastic records, nervous symptoms, or general adjustment, no known cases among them of delinquency and homosexuality, and a scattering of possible differences in other more minor respects. "The conclusion suggested by these detailed comparisons is that the Jewish subjects in this group differ little from the non-Jewish except in their drive for vocational success, their somewhat greater tendency toward liberalism in political attitudes, and somewhat lower divorce rate" (p. 310). It comes to mind in this connection that Witty and Theman found that gifted Negro children tended to resemble groups of American white children who were superior in test-intelligence.

A short account of war records is given in Chapter XXIV. More than one-half of the gifted men were above the age of 30 years when the United States entered the war. Three hundred and twenty-three or 42.5 per cent of the 760 men on whom information had been secured by late 1946 were enrolled in the armed forces, "exceeding that for all males in the country aged 18 to 44" (p. 356). Incomplete records gave 90 citations reported by 70 men—about 22 per cent of all the men of the gifted group who entered the services. Awards included 4 Legion of Merit, 5 Distinguished Flying Corps With Oak Leaf Cluster, 15 Purple Heart. Twenty-one, or 6.5 per cent of the men were killed or wounded.

Twelve women were in the services and, "between 50 and 60 women were engaged directly in war work either in government agencies or in private industry. Among the latter were engineering draftsmen, aircraft workers, radio mechanics, machine-shop workers, a supervisor of farm labor, and a truck driver. Those in government agencies served with the Department of Labor, the Office of War Information, the War Labor Board, and many other departments. They included economists, statisticians, editors, job analysts, secretaries, et cetera" (p. 356). Terman and others have shown elsewhere the tendency of gifted girls to be more interested in activities interesting to boys than is true of girls generally.

As to volunteer war work: "Blood-bank donations were mentioned by a large proportion. Other activities frequently mentioned had to do with civilian defense, ration-board work, the Red Cross, and the U.S.O." (p. 357).

Particular mention of Chapter XXIII must also be made: "Factors In the Achievement of Gifted Men." This is a somewhat expanded re-study of data originally presented in the Yearbook of the National Society for the Study of Education, 1940, Part I. Two groups called *A* and *C*, made up on the basis of ratings of "Vocational Success" were compared. The *A*'s were the 150 whom three judges considered "most successful" out of 730 on the basis of case records, and the *C*'s were the 150 adjusted "least successful"—roughly the top and bottom 20 per cents. The chapter covers 42 pages, obviously much too much for anything but briefest and most challenging extraction. Only five *IQ* points separated the groups, according to 1922 Binet *IQ*'s available on 188 of the 300 men concerned. Other differences, however, were marked.

> Everything considered, there is nothing in which the *A* and *C* groups present a greater contrast than in drive to achieve and in all-around social adjustment. Contrary to the theory of Lange-Eichbaum that great achievement is usually associated with emotional tensions which border on the abnormal in our gifted group success is associated with stability rather than instability, with absence rather than presence of disturbing conflicts—in short, with well-balanced temperament and with freedom from excessive frustration. The Lange-Eichbaum theory may explain a Hitler, but hardly a Churchill; a Goebbels, perhaps, but hardly a Goethe (p. 352).

Every administrator, teacher, and other adult concerned with guiding the growth and development of our American boys and girls, should become familiar with the major findings of the California 25-year study. On pages 3 and 4 the authors indicate their opinion of the need for knowledge in this respect. The last of "five essential features of the investigation as planned" (in 1921-22) was:

> One other thing should be made clear: the investigation as planned was not a direct attack upon the pedagogy of gifted children; it was instead a search for the basic facts that would provide a necessary prologomenon to further advances in this field of special training. Information must precede reform. It was lack of information that had made this region the darkest Africa of education. Once the physical and mental characteristics and the developmental tendencies of intellectually superior children have been definitely established, then, and only then, is it possible to plan intelligently for their education" (pp. 3-4).

The extent of sheer ignorance of facts and of misconceptions about gifted children still the case on the part of teachers and administrators is astonishing—frightening, too, because now, when emotional forces are so widespread and dominant in our country and throughout the world, we need all the wisdom and powers of understanding we can muster. Gifted persons, in the making and in adulthood, are unusually valuable for this reason.

Gifted children are both gifted and children. While their promise lies in both these natures, it is in the understanding of their growth needs that schools can, if they will, find ways to meet their individual needs, just as truly individual as those of the rest of us, and particularized as are ours. Through understanding helpfulness we may make contributions to fulfillment of promise, rather than being sharers in responsibility for wasted talents. Elsewhere Terman has said, "The achievement of gifted children cannot be credited in any degree to the school." Do we really mean that schools should concern themselves only with the average and below-average children?

The Gifted Child Grows Up calls for acceptance and understanding of and service to the delightful, hilarious, precious gifted children now trudging to and from our great country's schools, in whatever districts they may be, whatever may be their color, race, creed, sex or other superficial distinction. For them, but mostly for all of us, we, teachers, must learn the ways so that we shall not fail them.

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Child Behavior, Animal Behavior and Comparative Psychology

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FACTORS PRODUCTIVE OF CONDITIONED IMAGES OR SENSATIONS*[1]

The New York Hospital, Hunter College, and Cornell University

FRANCES CORN-BECKER, LIVINGSTON WELCH, VINCENT FISICHELLI, AND ETHEL TOBACK

A. INTRODUCTION

Perceptions occurring in the absence of adequate stimuli have been observed in varying experimental procedures.

Thus, Leuba (7) was able to produce post-hypnotic conditioned sensations of subjects through a conditioning technique while *in the hypnotic state.* In this manner auditory, visual, pain tactual, and olfactory conditioned sensations were evoked by 14 subjects in a group of 16. (Scott, 9, conditioned finger withdrawal from shock to the sound of a buzzer in subjects under hypnosis.)

Conditioned sensations, where *direct causal factors were emphasized to the subject,* have been reported by Brown (1) and Seashore (10). In these experiments, the subject was shown an elaborate apparatus for the production and control of a simple stimulus such as warmth, odor, or electric shock. The fact that the apparatus could produce the stimulus and increase it very gradually was demonstrated to the subject. Then, in a mock sensory acuity test, the stimulus was omitted, although the experimenter pretended to produce it. Under these conditions Brown found that 60 to 90 per cent of his subjects reported a perception in the absence of a stimulus. An incidental report of a conditioned sensation in an experiment by Cole (2) can also be explained in terms of a direct causal factor. In his report of a conditioned eyelid experiment (electric shock was the unconditioned stimulus) Cole reports the statement of a subject as follows: "That shock was awfully weak."

It has been shown by Ellson (4) that conditioned sensations can be produced *through the use of subliminal stimuli involving a difficulty of discrimination.* Ellson paired a light with a tone. The onset and decline of the tone was gradual, coming above the threshold usually several seconds after

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[1] Study from The New York Hospital and the Department of Psychiatry, Cornell University Medical College, New York; Hunter College, The Institute for Research in Clinical and Child Psychology, and Cornell University, Ithaca, New York.

the onset of the light. If the subject pressed a key during the interval when the light was on, but the tone was not, a conditioned sensation was reported. Other incidental reports of conditioned sensations in experiments involving the use of subliminal stimuli and difficulty of discrimination are those of Garvey (5) and Mowrer (8). Garvey, with shock as the unconditioned stimulus, conditioned respiratory changes to a vibrator or buzzer separately, and then tested the stimuli separately, and together, states that six out of eight subjects reported shock with the double stimulus although this double combination actually was never given. One subject reported each day for three days that the shock came with the double signal usually and seldom in any other combination. Thus, for this subject the shock was below the threshold of report. Mowrer used a shock which built up gradually from zero to a supra-threshold value. He states: "If after a series of presentations of the gradually increasing shock, the shock was completely withheld for a time, subjects almost invariably pushed the key."

E. L. Kelly (6), who specifically designed an experiment to produce conditioned sensations without the aid of hypnosis, obtained completely negative results. He paired tones with colors, with one of his subjects, as many as 3,000 times, but no subject reported the tone when the color was presented alone.

In an experiment by Corn-Becker, Welch, and Fisichelli (3), seven incidental conditioned sensations were reported. These could not be explained either on the basis of subliminal factors, as in the case of Ellson, or of Leuba, since there was no hypnotic situation, nor of the early experiments involving a direct causal factor (where the production of a stimulus by specific apparatus was demonstrated to the subject), but must be explained in other terms. The above mentioned experiment involved an association between the stimulus word presented on the lantern slide screen and its representative value to the subject. Thus, when the word "Breeze" was presented the subject reported feeling a chill.

B. The Problem

Our purpose in studying the six groups described below was to discover whether conditioned sensations could be produced (*a*) without hypnosis, (*b*) without direct causal factors, and (*c*) without the difficulties involved in discrimination between the presence or absence of an objective stimulus. We did, however, make use of conditioned and unconditioned stimuli that had symbolical relationship. In this sense two different series of words were used. We also attempted to discover the effects produced by blocking off distractions resulting from the flow of association of ideas, by means of a wire recorder giving instructions to the subject to "think of nothing."

First we attempted to produce a conditioned sensation along strictly Pavlovian lines in two of our groups where the word and its representative were shown. In these two groups the word "Cross" and a picture of a cross were presented simultaneously for 11 trials. On the 12th trial the word "Cross" was presented alone to determine whether the individual would have the conditioned sensation of the picture of a cross in the blank space alongside the word (Group I).[2] Secondly, we further attempted to see if such conditioning could be aided by blocking off internal distractions. Though the subject was in a sound-proof room in which there were no external distractions, there remained the possibility of distraction in terms of his own associations. Suggestions were given therefore, on a wire recorder, to "keep your mind blank," "think of nothing" (Group IIa).

In the third and fourth groups (Group IIIa and Group IIIb) we attempted to produce conditioned sensations at an abstract level of conditioning.[3] The difference between these two groups lay in the different stimuli used for each, and in the fact that the reinforcements in Group IIIa involved several sense modalities, depending on the particular word (the word "Music" was followed by the playing of music, etc.), whereas the reinforcements in Group IIIb were all visual, in that all the word symbols were followed by a picture for the word. Thus, the word "Circle" was followed by a picture of a circle.

In the fifth group (Group IV), we combined the recorded suggestions with the abstract conditioning level of Group IIIa to determine whether blocking out of internal distractions would facilitate the production of conditioned sensation at this abstract level.

In the last group (Group IIb), we combined the Pavlovian level with a wire recorder which gave instructions to the subject, not only to keep the mind blank, but to concentrate the attention of the subject on the screen. We assumed that if we would be successful in focusing the attention of the subject on the specific stimuli shown at a particular moment, we would be able to determine by the number of subjects who would give a visual conditioned response, as contrasted with the number who would condition in the Pavlovian group where the emphasis was to "think of *nothing*," whether concentration of a positive nature was an additional factor in producing conditioned sensations.

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[2] The necessary precautions were taken to make certain that this was not the effect of an after-image. Thus sufficient time was allotted between the 11th and 12th trials to rule out this possibility.

[3] This is not the generalization of Pavlov's dog, who through reinforcement by a bell to salivate to Pitch *A* now salivates to a bell of a slightly different pitch. This is a specific type of generalized conditioning where we are dealing with conditioning factors of past association. Through the use of word symbols we have built up in the subject this different generalization to produce a *CR* to an Un.S. which was never reinforced. We have referred to this as abstract conditioning in a previous paper (3).

C. APPARATUS

A Fordham two-stage *D.C.* amplifier, in series with an Esterline-Angus graphic ammeter delineated in permanent form all the deflections associated with changes in the skin resistance of the subject. The galvanometer was in circuit with the subject through silver electrodes held to the palms of his hands by rubber straps. The subject was seated before a lantern slide screen, on which appeared at randomized time intervals, and in randomized order the following words, one at a time: "Breeze, Red, Green, Music, Flicker, Dark, Nothing, Cross," and on the 9th slide the word "Cross" on one-half of the slide, with the other half of the slide blank. These slides were used in Group IIIa and Group IV.

The subjects in Group IIIb were shown slides with the following words: "Circle, Triangle, Square, Line, Zigzag, Star, Cross," and on the 8th slide the word "Cross" in smaller letters on one-half the slide, with the other half of the slide blank. These slides were presented in randomized order and at randomized time intervals.

The activation of all the stimuli was under mechanical control, devised by Welch (3). A button on the panel was pressed which simultaneously (*a*) activated a telechron motor (timed for four seconds); (*b*) seesawed five mercury switches; (*c*) activated the marker pen; (*d*) activated an electric counter; (*e*) turned off the top light for four seconds; (*f*) turned on the projector for four seconds. At the end of the four seconds, the seesaw was pulled down so that the motor automatically shut off its own current. When the procedure required reinforcement the assistant turned on a toggle switch (labeled to correspond to each individual stimulus) which activated the appropriate mercury switch for each individual stimulus. Thus, the toggle switch labeled "Green" was turned on, the button mentioned above was pressed, and a green light appeared simultaneously starting with all the activities mentioned above. The projector could be turned on, either through activating the telechron motor as above or independently by a push button by the experimenter in the room with the galvanometer.

Three rooms were used. The pathometer and graphic ammeter were under the control of the experimenter in the first room, the subject was in the second room, and the assistant who activated the various stimuli in the third room.

A wire recording (No. 1) was made by Welch in which he spoke to the subject as follows:

> We are trying to see how well you can relax. Think of nothing, absolutely nothing. Just let yourself fall into a drowsy state. Just try to relax. Think of nothing. Just let yourself go into a stupor. Do not fall asleep.

These instructions were repeated to the subject for the duration of the experiment.

The second wire recording (No. 2) instructed the subject as follows:

> Concentrate on the word that will appear on the lantern slide screen, and then relax until it is time for the next word to appear. Just relax. Think of nothing but the word that is on the screen, and anything else that is happening in the room. You will be drowsy until the word appears, and then you will be alert to what is happening on the screen. You will not fall asleep, but you will concentrate on the word on the screen.

D. Groups and Procedure

1. *Group I: Pavlovian Level Without Recorded Instructions*

In this group the word "Cross" was presented alone for 10 seconds at which point it was followed by the second slide having the word "Cross" with a picture of a cross next to it for four seconds. The picture of the cross was faint but clearly discernible.

There were 16 trials presented in randomized order and at randomized time intervals. On the 12th and 16th trials the word "Cross" alone was presented at which point it was followed by the second slide, this time the picture of the cross did not appear, though the word "Cross" on the first half of the slide remained. The wire recording was not played.

2. *Group IIa: Pavlovian Level With Recorded Instructions No. 1*

The procedure outlined above for Group I was used, the wire recording with the instruction to "Relax" being played throughout the presentation of the slides.

3. *Group IIb: Pavlovian Level With Recorded Instructions No. 2*

The procedure outlined for Group I was used. Wire recording No. 2 was played throughout the presentation of the slides.

4. *Group IIIa: Abstract Level Without Recorded Instructions*

The slides presented included the words "Breeze," "Red," "Green," "Music," "Flicker," "Dark," "Nothing," and on the 8th slide, "Cross" on half the slide leaving the other half blank; on the 9th slide, the word "Square," and on the 10th slide the word "Square," followed by picture square.

The words "Red," "Green," "Music," "Flicker," "Breeze," "Dark," and "Nothing," remained on the lantern slide screen for 10 seconds, at which point it was reinforced by its objective reality for four seconds. Thus, the word "Breeze" was followed by a breeze from an electric fan, the word "Red" was followed by a red light, the word "Music" was followed by the playing of music, etc.

On the 12th trial, the word "Square" was presented, and followed by a slide which had both the word "Square" and a picture of a square on it.

The word "Cross" was presented on the 16th trial for 10 seconds at which point it was followed by another slide with the word "Cross" on the first half of the slide, and the other half was blank. This second slide remained on for four seconds.

There were 16 trials, with the above slides presented in randomized order and at randomized time intervals. The word "Cross" in large letters, followed by the word "Cross" on only one-half the slide was presented on the 16th trial. In no instance did the picture of a cross ever appear.

5. *Group IIIb: Abstract Level Without Recorded Instructions*

The slides presented included the words "Circle," "Triangle," "Star," "Square," "Line," "Zigzag," and "Cross." Each slide remained on the lantern slide screen for 10 seconds at which point it was followed by another slide on which appeared the word which had immediately preceded it plus the visual representation of the word. Thus, the word "Circle," was followed by a slide with the word "Circle" and a picture of a circle next to it. There were, then, two sets of slides, one set which showed the word alone, and another set which included both the word and the picture.

There were 16 trials in which the above words were presented in randomized order and at randomized time intervals. On the 12th and 16th trials the word "Cross" was shown for 10 seconds, and followed by another slide with the word "Cross" in smaller letters on half the slide, the other half remaining blank. A picture of the cross was never shown.

6. *Group IV: Abstract Level With Recorded Instructions No. 1*

The procedure followed in this group was essentially the same as that in Group IIIa. There was, however, one change and one addition. The change consisted in showing the word "Cross" followed by the word "Cross" with half the slide remaining blank on the 12th trial as well as the 16th trial. This substituted for the word "Square" on the 12th trial in Group IIIa.

The addition was the inclusion of the wire recording No. 1 which was turned on with the presentation of the first stimulus word and continued through the entire experiment.

The instructions given to all the above groups were as follows:

> This is a test for the sweat activity of the palms of your hands. We require that you be in complete repose. The test will last about half an hour and therefore we will give you a simple task so that you won't fall asleep. You will read words and describe figures that will occasionally appear on the screen. We want you to do this in a special way. When you see the word "Man," you will say "Word Man" (this is demonstrated to the subject with the slide of the word "Man" appearing on it). If you were to see the word "Man" followed by a picture of a man you would say, "Word Man, Picture Man." Please say this loudly enough for the assistant in the next room to hear you. Now try the next one yourself.

(The slides representing word "Dog," and word "Dog," "Picture dog," were presented to determine that the subject understood the instructions.) In any instance in which the subject reported seeing a cross which was *not* present, the following procedure was to be followed:

Two slides, one with the word "Cross" alone, and the other with picture of a cross alone were presented for 12 trials in randomized order and at randomized time intervals. The word "Cross" was presented alone for 10 seconds, the telechron motor was activated which kept the projector on for another four seconds. At the appropriate time interval, the picture of the cross was presented for 10 seconds, and this time was followed by the ringing of a loud bell for four seconds. The *PGR* was recorded for the next four trials in which these slides were presented in random order, this time without the picture of the cross being reinforced with the bell. The above 16 trials were designated as Series *B*.

The next 16 trials (Series *A'*) repeated the first series.

If no conditioned sensation was reported, the experiment was over and the subject was asked the following questions:

1. Was it boring or monotonous?

2. What is your association to the word "Cross"?
3. Did you have any physical feelings? If so, describe them.
4. Did you see a cross? (Specific to Groups IIIa, IIIb, and IV.)
5. Did you see a cross every time? (Specific to Groups I, IIa, IIb.)
6. Did you visualize a cross?
7. Was the wire recorder successful in keeping your mind blank? Did your mind wander to your own personal thoughts? (Specific to Groups IIa, IIb, and IV.)
8. Did you have any particular reaction to the voice on the recording?

E. Subjects

One hundred and twenty subjects were used.

Group I: (20 subjects, Pavlovian level without recorded suggestions) consisted of 17 Hunter College students, two staff doctors and one medical student.

Group IIa: (20 subjects, Pavlovian level with recorded suggestions No. 1) consisted of 13 Hunter College students, two Payne Whitney staff doctors, four Payne Whitney Clinic laboratory technicians, and one Payne Whitney business administrator.

Group IIb: (20 subjects, Pavlovian level with recorded suggestions No. 2). This group consisted entirely of Hunter College students.

Group IIIa and IIIb: (Abstract level without recorded suggestions, 40 subjects) consisted of Hunter college students.

Group IV: (20 subjects, Abstract level with recorded suggestions No. 1) consisted of 17 Hunter College students and three staff doctors of the Payne Whitney Clinic.

F. Results

1. *Conditioned Sensations*

a. Group I: (Pavlovian level without recorded instructions, 20 subjects). One subject in this group reported seeing a cross on the 12th trial. We were unfortunately unable to establish differential conditioning as the bell went dead in the middle of Series *B*.

Another subject in this group, when asked if she saw the cross every time said, "Every time, except the last time."

Two subjects in this group reported that they did not see the cross more than two times. Actually it was not shown on the 12th and 16th trials only.

b. Group IIa: (Pavlovian level with recorded instructions No. 1, 20 subjects). One subject in this group reported: "Every once in a while a slight nervous reaction would run down my legs, particularly after I didn't see the picture of the cross."

There were two subjects in this group who reported seeing a picture of a cross on the 12th trial. There was no differential conditioning established. Both of these subjects stated after the experiment that they must have made a mistake.

There was one subject who reported seeing a picture of a cross on the 12th trial, and immediately retracted his statement, and said that it wasn't there.

c. Group IIb: (Pavlovian Group with recorded instructions No. 2, 20 subjects). There were four subjects in this group who reported seeing a cross on the 12th trial. Differential conditioning was not established in any of these subjects. After the experiment these subjects stated that they had not seen a cross. When the subject reported on the 12th trial "Picture Cross," they were asked by the assistant "What did you say?" They repeated "Picture Cross." This point will be discussed in greater detail later.

d. Group IIIa: (Abstract level without recorded instructions, 20 subjects). None of the subjects said that he saw a cross where there was none present. One of the subjects reported that she thought of the word "Cross" as angry, and had actually been angry about something before the experiment. She actually shivered at the word "Breeze" and reported a physical feeling of coolness at the words "Green" and "Dark."

e. Group IIIb: (Abstract level without recorded instructions, 20 subjects). None of the subjects in this group reported seeing a cross where there was none present. One subject in this group gave an association of anger to the word "Cross." In this instance, however, it was not her own feeling of anger, but that of her sister being angry at her, because she had lost an umbrella.

f. Group IV: (Abstract level with recorded instructions No. 1, 20 subjects). In this group, a visual conditioned sensation was reported to the word "Cross." Differential conditioning was produced in this subject as shown in the conditioned *PGR* response to the word "Cross," in Series *B*.

This conditioned response was evoked again in Series A^1 on the 12th and 16th trials, though the subject did not report seeing a cross on these trials.

Another subject in this group reported that he "was unsure as to whether there was a cross there."

From still another subject: "The word on this side, and something on the other side, but I don't remember what it was. In my mind there was a cross; it probably was a cross."

Another subject reported that she became angry when the word "Cross" was shown. She associated it with racial prejudice. The word "Red" actually produced cramps, reminding her of menstruation. The word "Breeze" made her feel more physically relaxed. She "felt good." She said she knew she had a physical feeling to the word "Music," but didn't remember exactly what it was.

Still another subject in this group reported seeing a green rectangle on the 12th and 16th trials.

And finally, there was one subject in this group who reported a feeling of warmth to the word "Red."

Table 1 shows the distribution of the conditioned visual sensation according to group.

TABLE 1
DISTRIBUTION OF CONDITIONED VISUAL SENSATIONS ACCORDING TO GROUPS

Groups	No. of conditioned visual sensations
I: Pavlovian level without recorded instructions	1
IIa: Pavlovian level with recorded instructions No. 1	2
IIb: Pavlovian level with recorded instructions No. 2	4
IIIa: Abstract level without recorded instructions	0
IIIb: Abstract level without recorded instructions	0
IV: Abstract level with recorded instructions No. 1	1

2. *Effects of Distraction*

The responses to those questions concerning the helpfulness of the voice in aiding concentration, and the attitudinal reactions to the voice were tabulated. Tables 2 and 3 summarize these responses.

Examination of these responses shows the voice in Group IIa (Pavlovian level with instruction to think of nothing) as the biggest irritator. The column headed "Irritating" included a range of comments from extreme

TABLE 2
ATTITUDINAL REACTION TO VOICE

Groups	Soothing	Neutral	Irritating	Total
Group IIa (Pavlovian level with recorded instructions No. 1)	8	2	10	20
Group IIb (Pavlovian level with recorded instructions No. 2)	6	10	4	20
Group IV (Abstract level with recorded instructions No. 1)	7	9	4	20
Total	21	21	18	60

TABLE 3
HELPFULNESS OF VOICE IN CONCENTRATION

	Undecided	Yes	Somewhat	No	Total
Group IIa (Pavlovian level with recorded instructions No. 1)	6	10	2	2	20
Group IIb (Pavlovian level with recorded instructions No. 2)	1	9	0	10	20
Group IV (Abstract level with recorded instructions No. 1)	8	9	0	3	20
Total	15	28	2	15	60

dislike, obnoxious, distracting, harsh, disagreeable, to annoying. There were such individual comments as "I wanted to tell him to shut up," and "I felt as though the voice were a whip over me." Those comments catalogued under "Soothing" ranged from extremely pleasurable, pleasant, to soothing. The difference of irritability between Group IIa and IV (both used suggestions to "think of nothing") where Group IIa showed the greatest amount of irritation, can be explained by the simplicity and monotony of the stimuli at the Pavlovian level. In group IIb (Pavlovian level with instructions to concentrate) the number of subjects giving responses of irritation shows a sharp decrease even though the same words of relaxation are spoken by the same voice. From the remarks of the subjects it appears that the voice was definitely helpful in Group IIa, which shows 10 "helpful" against two "not helpful" (the eight remaining subjects being undecided), and Group IV where nine reported the voice as "helpful," (with eight undecided). In Group IIb (Pavlovian level with instructions to concentrate) where approximately as many reported being helped as not, it must be noted that the positive results were greater despite these comments.

While it is known that subjective reports of this nature are often questionable, the analysis of these tables according to each group show marked differences according to the variable introduced into the experimental situation.

G. DISCUSSION

The Leuba experiment, involving conditioned sensations, established positive results in 14 out of 16 cases. It must be noted that the subjects he used were all excellent hypnotic subjects, and had been hypnotized several times before the experiment to determine if they were capable of producing deep trance phenomena, and post-hypnotic amnesia. It could not, therefore, be assumed that a similar procedure in unselected hypnotic subjects would give the same high percentage of success. This percentage would be further reduced in a group of subjects where no selection at all was involved. In the hypnotic trance not only is the flow of ideas almost completely cut off but the complete concentration of the subject is directed to a desired stimulus and is consequently much stronger. Thus, in our Group IIa, Pavlovian level with recorded suggestions No. 1, where the instructions were "Don't think of anything," we were less successful than in Group IIb where continuous instructions were given to the subject to concentrate. In Group IV, Abstract level with recorded suggestions No. 1, the suggestion method of ruling out associations aided the production of conditioned sensation. Thus, there was one conditioned sensation to the word "Cross" and two subjects reported that they were not certain whether or not they saw a cross. Furthermore, the word "Cross" produced a feeling of anger, the word "Red" produced cramps. "Breeze" produced a feeling of physical relaxation.

The subjective reports of the subjects in Group IIa differed from those of Group IV, in that the subjects (with one exception) had very little to say. The subjects in Group IV (abstract level with suggestions to "Think of nothing") had the greatest number of conditioned sensations other than visual ones, due, no doubt, to the fact that the past associations to the stimuli used in this group had greater experiential reinforcement for the individual.

The subjects in Group IIa felt that the experiment was tiring and uninteresting, whereas the subjects in Group IV reported it as interesting. This is shown by the greater richness of associations in the latter group as compared with the former.

A comparison of Group I (Pavlovian level without recorded suggestions) and Group IIIa (abstract level without recorded suggestions) showed one conditioned sensation in each group. In Group I, one subject had a conditioned sensation to the word "Cross." In Group IIIa there was one subject who shivered at the word "Breeze," and reported a physical feeling of coolness at the words "Green" and "Dark."

It would seem that there was either a relationship of direct symbolization (at the Pavlovian level), or an obvious association between the word and some characteristic of an association between the word and the situation in which the characteristic found expression (Abstract level). For example, the subject who experienced cramps to the word "Red" might have the following chain of associations: "Red" produced menstrual cramps, associated with blood which is red, etc.

In Group IIIb (Abstract level without recorded suggestions) it might be assumed that words such as "Circle," "Triangle," "Square," "Line," etc., are much less likely to have any associative value in a chance selection of subjects, whereas the words "Music," "Breeze," "Red," etc., would bring to the experiment a variety of past associations.

We obtained positive results at the Pavlovian level where Kelley did not because of the symbolic association which we had and Kelley did not, i.e., the word "Cross" was paired with a picture cross phenomenon that had been symbolically associated over the years. In Kelley's experiment, a color might be interpreted as a symbol for a tone but only for the period of the experiment. However, our attempts to rule out interference with the flow of ideas did seem to aid conditioning. At the abstract level, this method designated to control the distraction of the flow of ideas gave us success (at this level) in a limited sense. In Table 4, note the symbolical relationships between the word symbol and its association.

TABLE 4
CONDITIONED SENSATIONS AT THE ABSTRACT LEVEL

Stimulus word	Sensation reported by the subject
Breeze	Subject "actually shivered"; subject felt physically relaxed
Green	Felt cool
Dark	Felt cool
Cross	Two subjects saw a picture of a cross; one subject saw a green rectangle
Red	One subject felt cramps; one subject felt warm

As we have said before, there are two factors involved in producing conditioned sensations. There is (*a*) ruling out distraction and (*b*) enforcing concentration or sufficient motivation. Again, under hypnosis, a subject could be made to concentrate on uninteresting stimuli as he would not in a waking state. Owing to the extreme monotony at the Pavlovian level of simple conditioning (e.g., the word "Cross" followed by the picture cross trial after trial) concentration may have suffered from the dulling effect of the recorded suggestions. The introduction of these suggestions to "think of nothing," added to the uninteresting stimuli, may have been a factor in producing fewer positive results in this group. The suggestions in Group IIb to aid concentration seem to have counteracted the effect produced in the former group as shown by the greater number of conditioned sensations. At the abstract level, concentration on the stimuli may have been more intense, as there were different stimuli presented with activity at the same time, i.e., the word "Music" was followed by the playing of music, etc.

The incidental conditioned sensations that occurred in our experiment and which are presented in Table 2 seem to be the result of mechanisms operating before the experiment took place. We find, for example, that the appearance of the word "Red" elicited the conditioned sensation of a "cramp" in one subject. The subject herself explained that this probably occurred because of the association of blood with her menstrual cramps. Obviously, on many occasions, the color red had been associated with very painful sensations, thus involving strong motivation or attention. In this particular case, when external distractions were removed for a considerable period of time (10 or 15 minutes) the internal distractions from the normal flow of ideas were at a minimum, and lastly where the situation included one word after another being followed by the fact that it represented, the conditioned sensation of a cramp was elicited. It is hardly likely that this subject would have felt a cramp, if under ordinary circumstances she saw the word "Red" on a blackboard or in a book, or even saw a red patch on some sign.

Possibly such mechanisms are in operation in the pathological sphere, where some conditioned stimulus gives rise to a conditioned sensation called an hallucination.

H. SUMMARY AND CONCLUSIONS

In this paper we have reviewed the different methods and techniques used to produce a conditioned sensation. We have also set up an experiment which indicates there are additional factors that will produce the same phenomena.

A review of the literature indicates that previous methods can be categorized as follows: (*a*) where there is difficulty discriminating between the presence and absence of an objective stimulus; (*b*) where there are direct causal factors, and (*c*) where the conditioned sensation is produced under hypnosis.

In this study of 120 college students we have endeavored to produce conditioned sensations by (*a*) the simple Pavlovian technique which involves associating a word with a picture so that eventually the word may become a conditioned stimulus which will produce a conditioned sensation, i.e., the image of the word when the picture is not present, e.g., word "Cross" associated with picture cross. (*b*) We have attempted to obtain the same results at the abstract level of conditioning discussed in a previous paper, where the conditioned stimulus is not directly associated with the conditioned sensation. Because in the past the word "Red" has been associated with red light, the word "Breeze" has been associated with a breeze, etc., it is expected that the individual will experience a conditioned image, the image of a cross when the word "Cross" is flashed on the screen unaccompanied by any picture. (*c*) We have endeavored to decrease distraction at both the simple Pavlovian level and the abstract level by suggestions to "keep the mind blank and not think of anything" played on a wire recorder continuously throughout the testing period. (*d*) In another group, we have endeavored to not only decrease distraction by the wire recording method but to increase motivation by including suggestions to coöperate and concentrate on the stimuli presented. The introduction of these suggestions bring us to the threshold of the method of producing conditioning sensations by means of hypnosis. It is of course not identical. The subjects in this experiment are not hypnotized. They were being reminded to attempt to inhibit distracting thoughts and to concentrate on the stimuli. (*e*) We endeavored to investigate the possibility of conditioned sensations being produced by past associations in a situation where internal distractions from the normal flow of ideas are at a minimum.

1. In a group of 20 subjects we obtained one conditioned sensation at the Pavlovian level of simple conditioning, where other experimenters did not, because of the strong symbolic association between the conditioned stimulus and unconditioned stimulus absent from the prior experiments.

2. There were no conditioned sensations to the word "Cross" at the abstract level without recorded instructions in either of the two groups of 20 each tested. There were however, conditioned sensations to other of the stimuli in the group of 20 subjects using the words "Breeze," "Red," "Music," etc., while there were no conditioned sensations reported at all in the group of 20 subjects who were shown the words "Circle," "Triangle," "Line," etc., indicating the factor of past associations as being more meaningful in the former group than in the latter.

3. The suggestions given to "think of nothing" (20 subjects) used in conjunction with the Pavlovian simple conditioning were more successful in producing conditioned sensations than at this same level without the wire recording. The suggestions to "think of nothing" used in conjunction with conditioning at the Abstract level were more successful in the production of conditioned sensations than at this same level without the wire recording.

4. The suggestions presented by the wire recording to inhibit the flow of thoughts and concentrate on the stimuli being presented used in conjunction with the Pavlovian simple conditioning gave us the greatest number of conditioned sensations. In this group of 20 subjects there were four conditioned sensations.

5. It would seem then that two essential factors are involved in the production of conditioned sensations. They are (*a*) ruling out distraction, and (*b*) enforced concentration or sufficient motivation. As we introduced

an additional factor in each of the groups, we increased the number of conditioned sensations in that group.

Incidental conditioned sensations that occurred seemed to be the result of mechanisms operating before the experiment took place. The eliciting of such conditioned sensations by words may be possible in a situation where external distractions are removed for a considerable period of time, internal distractions from the normal flow of ideas are at a minimum, and where the situation includes one word after another being followed by the fact it represents.

Although it is known that subjective reports are often questionable, an analysis of each group of the subjective responses of the subjects as to the helpfulness of the wire recording and the subjects' attitudinal reactions to the voice making the suggestions on the recording, shows a marked difference of the effect of the two types of recording used.

Possibly the mechanisms found operating in this experiment are operative in the pathological sphere, where some conditioned stimulus gives rise to a conditioned sensation called an hallucination.

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CONSISTENCY AND VARIABILITY IN THE GROWTH OF INTELLIGENCE FROM BIRTH TO EIGHTEEN YEARS*

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A. THE PROBLEM AND THE SUBJECTS

Various explanations have been offered for the changes which occur in the *IQ*'s of many children as they grow older. Among these explanations it has been suggested previously that irregularities may be due, at least in part, to innate differences in the tempos of children's maturational processes (4). However, the extent to which this hypothesis is true, if at all, is obscured by certain characteristics of the testing instruments on which we rely.

If we use several different tests of intelligence, the resulting variations in scores will be in part a function of the methods of standardization; including such things as the nature of the standardization sample, and the method by which the scores are obtained. They will also be in part a function of the kinds of intellectual abilities tested. That is, some scales test primarily verbal abilities; others weigh more heavily mathematical, or spatial functions, and so on. Another variable factor is the relative freedom of the test items from cultural and educational influences (11). There is also, of course, the further difficulty of determining the various effects of environment in stimulating or retarding intellectual development.

It is not proposed here to deal with the environmental aspects of the problem, but rather to examine some of the trends of intellectual development as found in some currently used tests of intelligence when applied to a small but constant sample, from birth through 18 years of age.

Ideally, for purposes of measuring the rates of intellectual growth in individual children, we should be able to measure the same children from birth to maturity on a single test which is applicable over the entire age range. Such a test, furthermore, should be calibrated in absolute units, so that velocities of growth in individuals and over different segments of the span may be compared directly. However, in spite of repeated efforts to produce them there are no existing intelligence tests which meet either of these

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criteria. It now seems unlikely, from the very nature of the growth of intellectual abilities, that such a test can ever be devised. The mental behaviors which are developing during the first year of life are very different from those developing in the three-year-old who has learned to talk fluently, and these in turn are very different from the complex mental functions of later ages. From an examination of the nature of the intellectual functions available for testing, the growth of intelligence would appear to be the maturing of a succession of partially overlapping functions which become increasingly complex as they approach adulthood (4, 5).

We cannot, then, expect to have a single test of intelligence which is applicable at all ages. Such a test, for example, as the Stanford-Binet, which extends from two years to adult levels, though called one test, is made up of a series of *different* items which change in nature as they become more difficult. The extent to which these items and similar items in other tests are measuring the same things can be judged more adequately after large numbers of normal representative children have been tested and retested at successive ages, and their test scores compared.

We are beginning to accumulate such series of tests on the same children. Most of the groups of children on whom longitudinal test data are available are not average samples but tend to be superior. Nevertheless, much valuable information about the nature of intellectual growth has come and will continue to come from such studies because they are concerned with the growth of individuals through time. We may hope eventually to fill in the gaps with growth records from more average and below-average population samplings, as well as from more adequate tests.

The Berkeley Growth Study children, as reported previously (9), come, for the most part, from socio-economically superior homes. What is more, their intelligence scores tend to be well above the average. There were originally 61 infants enrolled: 40 of them have continued in the study through most or all of their 18 years. The principal contribution which the Berkeley Growth Study records can make to our knowledge about the nature of mental growth is in the length of the age span for which test scores are available. Although the number of children observed is not large, these same children have been tested repeatedly, at regular intervals throughout their lives. The further facts that the children were tested at most ages by the same examiner,[1] and that all had a similar program of testing experience given under the same general situational conditions, contribute to the comparability of the test scores. These conditions make it possible to study both the growth trends of individual children and the relations of age and test to scores for a constant sample.

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[1] All tests were given by the author, with a few exceptions. Occasional infant tests were given by Dr. L. V. Wolff, the pediatrician who participated in the program of infants' tests and measurements; most of the two-year tests were given by Dr. Marjorie Pyles Honzik; and the eleven-year tests were given by Dr. Mary Shirley.

The schedule of the study includes mental tests at most or all of 38 ages for the 40 children. The tests considered in this paper, with the ages at which they were administered, are as follows: The California First-Year Mental Scale (7), given at one-month intervals through 15 months; the California Preschool Scale (23), given at three-month intervals through three years, and at six-month intervals through five years; the Stanford-Binet, 1916 Revision, at six and seven years (35); the 1937 Revision (37), Form *L* at 8, 9, 11, and 14 years, Form *M* at 10, 12, and 17 years; the Terman-McNemar Group Test (36), Form *C* at 13 years, and Form *D* at 15 years; and the Wechsler-Bellevue (39), Form *I*, at 16 and 18 years. The scoring procedures for these various tests are different, and they are standardized on samples which were selected by different criteria, with resultant norms which are not equivalent in difficulty. Comparisons on this sample are made in respect both to the standard norms, and to methods adopted for the study of intra-group relationships.

Several aspects of these children's mental-test scores have been reported in previous studies, for the earlier ages up to and including nine years (4, 5, 6, 8). As shown in these studies, there was little or no relation between their mental test scores before two years of age and their scores at later ages. Similar results from other studies have convinced most investigators that existing tests of infant intelligence are inadequate for predicting children's later intelligence. Two alternative explanations of this inconsistency in early test scores have been suggested: (*a*) It may be that although we have not yet found the right tests, further search will reveal some infant behaviors which are characteristic of underlying intellectual functions, whose nature is such that they can be used for purposes of predicting the quality of intelligence at later ages. Or (*b*) early intellectual growth may be variable (either inherently so, or through environmental influences), making it impossible to predict later intelligence from any aspects of early infant behavior.[2]

B. THE SELECTION OF MORE PREDICTIVE TEST ITEMS

In the search for items of infant and preschool child behavior which may prove of predictive value, L. D. Anderson (3), Bradway (10), and Maurer (28) have made studies in which the scores made at a later age were used as criteria for selecting items or groups of items from tests given the same children at younger ages. Anderson compared 5-year *IQ*'s with test scores earned between three and 18 months. Bradway retested 10 years later children from the two- to five-year standardization sample of the 1937 Stanford-Binet. Maurer retested at 15 years children who had been given the Minnesota Preschool Scale at 18 to 54 months. The results of these studies are interesting but have not so far given us any adequately predictive batteries of tests. Both Anderson and Bradway found language or verbal items to be in general most predictive. Maurer found that the most predictive items required attention and adaptation, but that language entered in only after it had acquired the status of a well-developed tool. All three authors selected items of the type which they felt should be assembled for tests which might prove more useful than current tests in predicting intellectual growth.

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[2] Except in cases of extreme retardation.

As yet no complete item-by-item analysis has been made on the Berkeley Growth Study children. But various aspects of intelligent behavior, such as vocabulary and form-board performance, were compared over a period of years, as well as several different combinations of mental-test items (5). Recently a preliminary analysis of items has been made by comparing the six brightest with the six dullest 16-to 17-year-olds. A selection was made of those items in the First-Year Scale which were passed (on the average) at least two months younger by the bright group than by the dull group. Thirty-one items met this criterion. Cumulative point scores composed of these 31 items still did not reliably differentiate the bright from the dull ones during the first year. For the 12 ages (months 3-14) at which scores were computed, only six of the 12 children made scores which were consistently in the same general direction (i.e., above or below the average for the 12 cases) as their 17-year scores. It seems unlikely that correlation coefficients for the entire group would be significantly above zero.

In all of the comparisons so far made on the Berkeley Growth Study children, little consistency in relative scores could be found during the first two to four years. After this age, however, intellectual progress became fairly stable.

C. THE MEANS OF MENTAL AGE AND *IQ* SCORES FROM ONE MONTH THROUGH 18 YEARS

The data for the first three years have heretofore been reported in the form of point scores and sigma scores. For purposes of comparison with other data, mental ages have been computed for the First-Year Mental

Scale. To do this the mean cumulative point score at each age tested was called the mental age for the corresponding chronological age. Then *MA*'s (in months and tenths of a month) were interpolated and assigned to each point score. *IQ*'s were computed by the usual *MA/CA* ratio. *IQ*'s were computed for the California Preschool Scale and subsequent tests according to the published directions for each scale.

The relative status of the Berkeley group may be seen from the curve of their mean mental ages in Table 1 and in Figure 1*a*. These children constituted the standardization sample for the First-Year Scale,[3] and composed a part of the sample for the Preschool Scale: therefore the mean mental

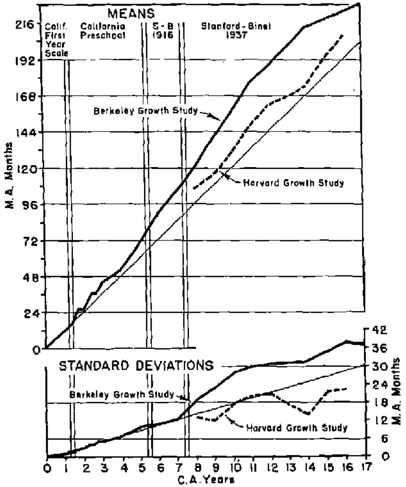

FIGURE 1
CURVES OF THE MEANS AND STANDARD DEVIATIONS OF MENTAL AGES FOR THE BERKELEY GROWTH STUDY CHILDREN FROM ONE MONTH THROUGH 17 YEARS, WITH COMPARABLE DATA FROM THE HARVARD GROWTH STUDY FOR YEARS EIGHT THROUGH 16

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[3] No adjustment in these early mental ages was attempted. In view of the lack of correlation between earlier and later scores, we would not expect these children to show superior mental scores during the first year. The only other published data for the California First-Year Scale, those of Dubnoff, show the Russian infants she tested to be superior to our norms during the first nine months (13).

TABLE 1
MEANS AND *SD*'S OF MENTAL AGE AND *IQ*, BY AGE AND TEST (Berkeley Growth Study)

Age	Test	*N*	Mental age in months*		*IQ*	
			Mean	*SD*	Mean	*SD*
Mo. 1	Cal. First-Year	52	1.04	.195	103.8	19.5
2	Cal. First-Year	58	1.998	.34	101.8	16.9
3	Cal. First-Year	61	2.92	.41	97.5	13.6
4	Cal. First-Year	58	4.01	.51	101.0	12.9
5	Cal. First-Year	58	5.00	.60	100.3	12.3
6	Cal. First-Year	57	5.96	.79	99.1	13.2
7	Cal. First-Year	52	7.03	.705	100.7	10.2
8	Cal. First-Year	53	8.08	.77	100.9	9.7
9	Cal. First-Year	56	9.01	.77	100.1	8.5
10	Cal. First-Year	56	10.13	.75	101.3	7.6
11	Cal. First-Year	52	11.03	.78	100.9	7.5
12	Cal. First-Year	53	12.06	.82	100.7	6.7
13	Cal. First-Year	53	13.04	1.07	100.3	8.4
14	Cal. First-Year	46	14.08	1.12	100.7	8.1
15	Cal. First-Year	52	15.00	1.38	100.0	9.3
18	Cal. Preschool I	49	18.38	2.20	102.4	12.0
21	Cal. Preschool I	52	22.59	2.47	107.6	11.7
24	Cal. Preschool I	47	26.29	3.09	109.5	13.3
27	Cal. Preschool I	48	30.48	3.69	112.6	13.6
30	Cal. Preschool I	46	33.96	4.11	113.1	13.6
33	Cal. Preschool II	44	37.04	4.87	111.6	15.0
36	Cal. Preschool I	47	42.83	5.20	118.8	14.4
42	Cal. Preschool I	39	49.39	5.50	117.6	13.2
48	Cal. Preschool I	44	52.28	6.64	109.4	14.1
54	Cal. Preschool I	43	62.28	8.03	115.0	15.2
60	Cal. Preschool I	46	70.60	9.90	117.8	16.9
Yr. 6	Stanford-Binet '16	48	88.71	11.01	123.4	15.6
7	Stanford-Binet '16	46	103.65	12.64	123.0	15.1
8	Stanford-Binet L	47	120.00	18.91	122.6	20.1
9	Stanford-Binet L	45	139.40	23.56	129.0	22.2
10	Stanford-Binet M	47	157.96	28.75	131.9	23.6
11	Stanford-Binet L	45	174.51	30.22	132.5	22.1
12	Stanford-Binet M	43	186.93	31.71	130.3	22.1
13	Terman-McNemar C	36	—	—	115.6	21.4
14	Stanford-Binet L	37	213.08	31.85	129.9	19.2
15	Terman-McNemar D	37	—	—	121.7	19.1
16	Wechsler-Bellevue	39	—	—	117.4	16.2
17	Stanford-Binet M	40	231.55	36.08	129.1	19.9
18	Wechsler-Bellevue	37	—	—	122.1	16.1

*Data ungrouped.

ages and *IQ*'s for the first five years cannot be used for estimating the representativeness of the sample. For school ages, we see that the group is superior to the Harvard Growth Study cases as reported by Dearborn and Rothney (12), and included in Figure 1 for comparison. It is far superior to the test norms, as represented by the straight diagonal line. Some of this superiority we may attribute to practice effect and test sophistication.

The means of the *IQ*'s are presented in Table 1 and Figure 2. It is obvious from their shifts, which range between 116 and 132 on the standard tests given after five years, that the norms used are not of equivalent difficulty at all ages. Stanford-Binet *IQ*'s average considerably higher than either the Terman-McNemar or the Wechsler.

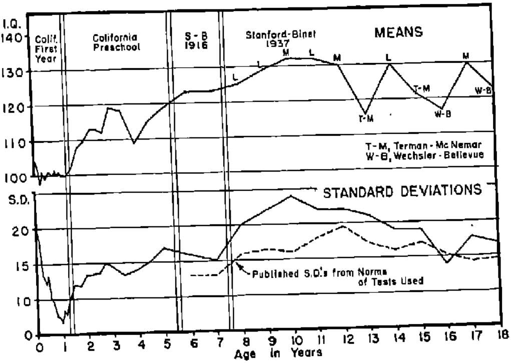

FIGURE 2
CURVES OF THE MEANS AND STANDARD DEVIATIONS OF *IQ*'S FOR THE BERKELEY GROWTH STUDY CHILDREN FROM ONE MONTH THROUGH 18 YEARS

Similar results are reported by other investigators. Sartain (33) for example, found that for 50 college freshmen, "*IQ*'s on the New Revised Stanford-Binet were significantly higher than those on the Bellevue Scale or the Otis Self-Administering Test of Mental Ability." He reported a Stanford-Binet *L* mean *IQ* of 129.48, *SD* 10.92, and a Wechsler-Bellevue Full Scale *IQ* mean of 117.48, *SD* 10.47.

The 1937 Revision yields higher scores for the Berkeley Growth Study than the 1916 Stanford-Binet. Ebert (14) has compared the 1916 and 1937 Stanford-Binets on a similarly selected superior group, and found consistently higher means on the 1937 Revision. But Ebert also found a consistent tendency for the means of this last revision to increase with age from six to 10 years, as our means do from eight to 10. Therefore a part of the change in our means from the 1916 to the 1937 revision would seem to be a function of the *ages* at which the tests were given. Another factor which is probably operating here is the general superiority in intelligence of this group. The distribution of scores in this sample might very well be different for the two tests (1916 and 1937 Stanford-Binet). Although McNemar (29) found symmetrical distributions of *IQ*'s for the standardization sample, others (e.g., 32) have found that *IQ*'s above 100 on the 1937 Stanford-Binet are more variable than those below 100. If this is true it might account for both the higher means and the larger *SD*'s found for this test, as compared with the other tests, both for these children and for other above-average samples. (Our *SD*'s for the Terman-McNemar and the Wechsler-Bellevue are more nearly like those of the published norms.)

Scores on the second administration of both the Terman-McNemar and the Wechsler-Bellevue are higher than the first scores for each of these tests, even though the interval between the two administrations of a given test is two years. This might be due to specific practice effects.[4] Or it may indicate inadequate allowance in the standardization for intellectual growth during these late adolescent years. The *IQ*'s for both the Terman-McNemar and the Wechsler-Bellevue are not *MA/CA* ratios, but statistical equivalents, based on the means and *SD*'s of their standardization groups. When cross-sectional samples are used for standardization it is often difficult to secure groups of comparable abilities for successive years, especially at these ages when many children are dropping out of school. Although most test norms are based on the assumption that adult intelligence is reached by 16 or 17 years, a number of studies (18, 24, 25) indicate that intellectual growth continues, on the average through 18 years, and even at least for some persons, to around 21 or 22 years.

D. VARIABILITY OF SCORES

1. *Mental Ages*

More significant than the means, it seems to me, is the trend of the standard deviations of mental ages from birth through 17 years (Table 1 and Figure 1*b*). It is plain that the *SD*'s do not increase at the constant rate which is necessary if *IQ*'s are to remain constant during growth. The *SD*'s are too small during most of the first year and too large after seven years, and especially at 9, 10, and 11 years. These variations cannot be attributed to inequalities in the sampling of cases, as they are based on essentially the same cases throughout. But the Berkeley children are not alone in showing these age trends in variability. Although the Harvard Growth Study *SD*'s are smaller for the same ages (see Figure 1*b*), they agree in indicating greater variability in scores from 9 to 11 years, in a sample which is also primarily "longitudinal" (12, p. 170).

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[4] All of these children are so accustomed to taking tests that we can attribute very little effect, at these ages, to any general learning experience in test-taking.

2. *IQ's*

The *SD*'s of the *IQ*'s are given in Table 1 and shown graphically in Figure 2*b*. These standard deviations show strikingly why the *IQ* is a poor instrument to use in predicting later intelligence. When *IQ*'s are used these children's scores are most variable at one month (when the *SD* is 20) and around 9 to 11 years (when it goes as high as 24); and least variable around one year (when it drops below seven *IQ* points). The variability tends to diminish again as maturity is approached.

The distributions of *IQ*'s from six to 18 years are shown in Figure 3. Although statistical tests indicate that these distributions are within the limits of normal for samples of this size,[5] it is apparent that the high *IQ*'s are limited at the later ages. The usual interpretation of such a curtailment of high scores is that the tests used do not have enough "top" for the brighter children. Another possible explanation is offered later in this paper.

E. VARIABILITY OF SCORES IN A STRICTLY CONSTANT CASE SAMPLE

Although the data presented thus far are on the same children for the most part, a glance at the *N*'s in Table 1 shows that all 61 children were present at only one test age (three months). There is, thus, some fluctuation from age to age in the composition of the sample. It has been possible to select 21 ages, fairly well distributed over the 18-year span, at which the same 27 children were tested. The data on *IQ*'s for this sub-sample, for all of whom there are scores at all 21 ages, are given in Table 2 and Figure 4. We have here sacrificed cases and testing ages to gain constancy of sample. The same age trends in means and *SD*'s are found. This rules out the possibility that variations may be due to inconstant sampling of cases.

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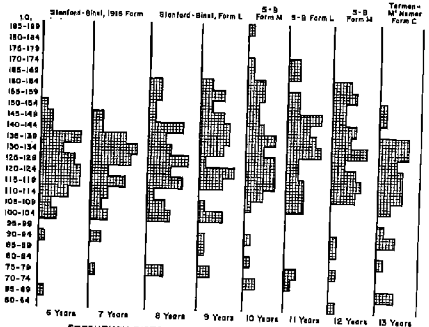
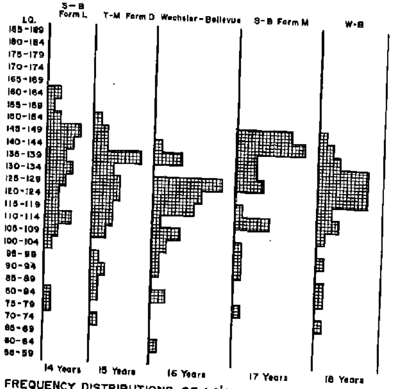
[5] Beta coefficients (30).



FREQUENCY DISTRIBUTIONS OF I.Q.'S AT SUCCESSIVE AGES
COMPARING SEVERAL DIFFERENT TESTS, AND THE SAME TESTS AT DIFFERENT AGES
BERKELEY GROWTH STUDY CASES



FREQUENCY DISTRIBUTIONS OF I.Q.'S AT SUCCESSIVE AGES
COMPARING SEVERAL DIFFERENT TESTS
AND THE SAME TESTS AT DIFFERENT AGES
BERKELEY GROWTH STUDY CASES

FIGURE 3

FREQUENCY DISTRIBUTIONS OF *IQ*'S AT SUCCESSIVE AGES (*a*) YEARS SIX THROUGH 13, (*b*) YEARS 14 THROUGH 18

TABLE 2

Means and *SD*'s* of Mental Ages and *IQ*'s of 27 Selected Cases

CA		Mental age in months Mean	Mental age in months *SD*	*IQ* Mean	*IQ* *SD*
Mo.	3	2.97	.46	99.07	15.35
	4	4.03	.45	100.59	11.02
	5	5.07	.62	101.78	12.15
	6	6.10	.74	101.56	12.28
	8	8.28	.67	103.48	8.40
	13	13.11	1.04	100.93	7.99
	15	15.08	1.32	100.56	8.64
	18	18.54	2.30	102.74	12.73
	21	22.56	2.05	107.19	9.73
	24	26.13	2.27	108.48	9.10
	27	29.59	3.15	109.48	11.88
	30	34.35	3.34	114.41	10.92
	36	41.84	4.52	116.19	12.68
	42	48.39	5.18	115.04	12.16
	48	51.07	5.35	106.74	11.28
Yr.	7	105.26	10.08	124.96	11.85
	9	143.63	21.09	132.81	19.52
	11	180.96	27.52	137.15	20.75
	14	217.33	28.92	132.59	17.70
	15			122.70	18.37
	16			120.52	12.12
	17	236.67	25.94	131.52	14.43
	18			124.44	12.28

*Data ungrouped.

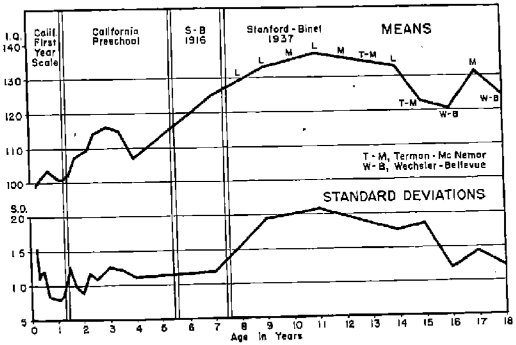


FIGURE 4

Curves of the Means and Standard Deviations for a Strictly Constant Sample of 27 Berkeley Growth Study Cases at 21 Test Ages

F. AGE CHANGES IN VARIABILITY FOR DIFFERENT TESTS

1. *Infant Tests*

The question arises whether changes in variability are due to the particular tests used. In Figures 5 and 6 some data are assembled on *SD*'s which have been published on tests of infants. The curves in 5*a* are *SD*'s of point scores for two groups of infants—the Berkeley cases (4) and Russian babies tested by Dubnoff (13)—who were given the California First-Year Scale. In 5*b* are *SD*'s of point scores reported by Fillmore for her Iowa Infant Scale (17) and by Nelson and Richards for the Gesell Schedules given to children in the Fels Foundation growth study (31). In Figure 6 are *SD*'s of *IQ*'s, for the Berkeley Growth Study, and *PE*'s of Kuhlman-Binet *IQ*'s as reported by Kuhlman[a] (26). For all tests and samples, and for different methods of scoring, there is decreased variability in scores at or near one year of age, with the *SD*'s increasing as we go either up or down the age scale from there. The consistency of these trends suggests that children are less variable in their behavior-maturity patterns at one year than earlier or later. An additional piece of evidence which may support such an hypothesis is given by L. D. Anderson (3). In his validation of infant test items by correlation with five-year *IQ* he found only five items (from a total of 97) at the one-year level which were "predictive." There were, by contrast, 16 items at six months and 18 items at 18 months.

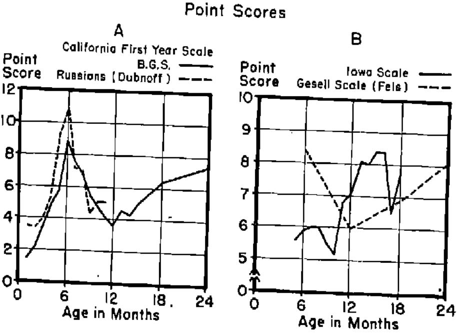


FIGURE 5

AGE CURVES OF THE STANDARD DEVIATIONS OF POINT SCORES REPORTED FOR SEVERAL DIFFERENT INFANT TESTS

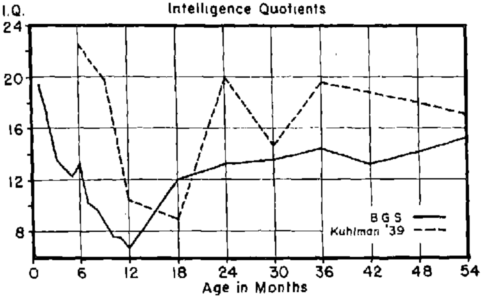


FIGURE 6

AGE CURVES OF THE STANDARD DEVIATIONS OF *IQ*'S: THE BERKELEY GROWTH STUDY COMPARED WITH THE KUHLMAN-BINET

2. *Tests From Two to 18 Years*

There is, furthermore, evidence from other studies indicating changes in variability at other ages. Goodenough (19) has called attention to the trends in the 1937 Stanford-Binet norms. The *SD*'s of *IQ*'s in the standardization sample, as reported by Terman and Merrill (37), show trends which Goodenough suggests are inherent in the tests, and not due to chance variations in sampling as Terman and Merrill had assumed. These *SD*'s tend to decrease from two and one-half years to six years, when they are smallest, then to increase to a high level from 11 to 15 years, after which they drop again. McNemar (29) agrees that the changes in variability are probably not due to chance, and has set up a table for correcting *IQ*'s at the ages where the *SD*'s are smallest and largest.

We have made one check on the relation of case sampling to variability in the 1937 Stanford-Binet, for a part of its range, by comparing the 34 Berkeley Growth Study children who took the test at all seven ages from eight through 17 years. Form *L* was given at four ages, and *M* at three ages. The means and *SD*'s are given in Table 3. Whether we regard these as the same test, or two different tests, the trends are evident. The age changes in variability do appear to be characteristic of the test.

This characteristic trend, however, is not confined to the 1937 Stanford-Binet tests. Such other published material as the Harvard Growth Study

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[6] The Kuhlman-Binet *PE*'s, as he uses them, are interquartile ranges (26). They are from his Table 28 and Figure 1.

TABLE 3
MEANS AND *SD*'S STANFORD-BINET (1937 REVISION) MENTAL AGE AND *IQ* FOR 34 BERKELEY GROWTH STUDY CASES

CA	Mental age, months		*IQ*	
Years	Mean	*SD*	Mean	*SD*
8.0	119.76	18.67	124.33	19.75
9.0	139.32	22.63	129.18	21.83
10.0	159.18	27.71	132.12	23.47
11.0	174.03	30.27	131.97	22.49
12.0	189.47	29.79	131.53	20.88
14.0	209.62	32.54	127.85	19.61
17.0	230.65	32.41	128.00	18.23

(See Figure 1) which adapts scores from several tests (12, 34), the studies of Freeman, *et al.*, of mental growth in Chicago children (1, 18), Ebert and Simmons' report on the Brush Foundation children of Cleveland (15), and data reported by Goodenough on Minnesota children (19, 20), all give greater *SD*'s for mental test scores around 10 to 12 years of age than in the periods just before or after. The *PE*'s (and hence the *SD*'s) of Kuhlman-Binet *IQ*'s tend to drop from two to six years, and to rise after six but become large and erratic after 13 years (26).

These studies include a variety of testing instruments, and both cross-sectional and longitudinal samples. The trends in variability are, of course, to some extent peculiar to the particular tests used. But there is enough concomitance in these trends to merit an investigation of the possibility that the tests may be reflecting underlying growth processes.

G. VARIABILITY: THEORETICAL CONSIDERATIONS

Although the age changes in variability[7] may be artifacts of current methods of selection and standardization of test items, they may equally well describe tendencies which are inherent in intellectual growth. It seems quite probable that both of the clear-cut periods of restricted variability in the Berkeley Growth study intelligence scores—toward the end of infancy and of adolescence—are due to the approach to maturity of the particular processes being measured. The mental processes which are developing during the first year are largely sensory-motor in character (2, 4). And although they form the basis for further intellectual development, precocity or retardation in them is not necessarily related to rates of development in the more complex processes which we call intelligence in school-age children and adults. By one year of age most of the slow developers have caught up with those who were precocious in these simple coördinations. The *SD*'s thus become restricted to individual differences in mature functions.[8] In the same way the approach to mature intellectual status after 11 or 12 years could reduce the variability of performance as the children whose mental growth is more accelerated reach their own "ceilings."

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[7] The coefficient of variation, as used by Ellis (16) and Henmon and Livingstone (21) for example, seems inapplicable here. *V* only seems to minimize or obscure changes in variability which are of practical significance.

On this interpretation the ceiling is a function (at least in part) of the child's changing growth rate, rather than of a scarcity of difficult items at the upper levels of the test. This is shown very clearly in the study of Freeman and Flory (18, pp. 38-41), who were concerned over the reduced *SD*'s on their *VACO* tests after 15 years. They attempted to increase the variability of scores on the upper levels of the Analogies test by adding top in the form of more difficult items. However, they did not succeed in changing the trend. An analysis of their Opposites test likewise indicated that its reduced variability at later ages was not due to a lack of differentiating items at the upper end of the scale.

It thus seems likely that the test scores are reflecting actual changes in variability which are inherent in the processes of development of any given function. During growth of a structure or function variability increases, in part because of increasing individual differences in capacity, and in part because of individual differences in the speed with which the maturing process takes place. These two factors are known to be operative in physical growth, and it seems reasonable to expect that they may be characteristic of many growth processes. During the stage of development when both factors operate freely, the variability of measures or scores will become greater with the general increments in the structure or function concerned. But as an increasing number of individuals stop growing, and the means level off to a constant value, the individual differences which remain become restricted to those of the achieved mature state. On this hypothesis, we should assume that in the present series of tests of mental growth we have scores on at least two types of function which develop successively, resulting in alternating periods of increasing and decreasing variability. These large general trends may well obscure similar tendencies, which are occurring more or less simultaneously, in more specific functions which develop in various parts of the growth span. The *VACO* tests are examples of this, as is seen in the varying trends of means and *SD*'s of the four tests in the Freeman and Flory Study (18). Thurstone (39) in testing five- and six-year-olds, found that certain factors seemed to mature much earlier than others. Another example is found in the study of Jones and Conrad (24) for the subtests of the Army Alpha between the ages of 10 and 60 years. This last study indicates wide variations in rates of decline of different intellectual functions, as well as in their rates of growth. It is reasonable to expect that similar differences will be found in any broad sampling of mental functions.

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[8] This point has been discussed in detail in my monograph on Mental Growth during the First Three Years (4).

H. Consistency of Growth in Intelligence

1. *Method of Scoring*

We have thus far discussed three different conditions which militate against a child's maintaining a "constant *IQ*" throughout his growth. First, differences in standardization from one test to another, with differences in relative difficulty, cause spurious changes in the *IQ*'s. This is shown in the considerable differences in mean *IQ*'s of the Berkeley Growth Study children for the different tests used. Second, we have found age changes in variability of the tested mental functions, so that if relative intellectual status is expressed either by scaled point scores[9] or by the ratio *MA/CA*, the scores of exceptional children are necessarily brought closer to the average during periods when variability is reduced. Third, it would appear that different functions are being measured on different segments of the mental growth span.

To eliminate, as far as possible, changes in the scores for our sample which may be due to either of the first two factors, we have transposed all of their mental test scores into Sigma Scores computed from the means and *SD*'s of the points earned by this group of children at each age tested.[10] Using these Sigma Scores, or Standard Scores, we can determine both for the group as a whole, and for the individual child, the extent to which the children maintain constant positions in a total group which has had similar testing experience.

2. *Relation to Age and Test-Retest Interval*

We have computed several series of correlation coefficients between tests given at successive ages, to determine the extent to which predictions can be made for the children in the group, for different ages and for different intervals between tests. Samples of these *r*'s are shown graphically in

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[9] Freeman and Flory (18).

[10] Sigma Scores have for some purposes been transposed into their equivalent Standard Scores by multiplying by 10 and adding 50, thus eliminating all minus figures.

TABLE 4

CORRELATION COEFFICIENTS BETWEEN AGE-LEVEL STANDARD SCORES OF INTELLIGENCE*

Av.of months	4, 5, & 6	7, 8, & 9	10, 11, & 12	13, 14, & 15	18, 21, & 24	27, 30, & 36	42, 48, & 54	Years 5, 6, & 7	8, 9, & 10	11, 12, & 13	14, 15, & 16	17, 18
1, 2, & 3	.57	.42	.28	.10	—.04	—.09	—.21	—.13	—.03	.02	—.01	.05
4, 5, & 6		.72	.52	.50	.23	.10	—.16	—.07	—.06	—.08	—.04	—.01
7, 8, & 9			.81	.67	.39	.22	.02	.02	.07	.16	.006	.20
10, 11, & 12				.81	.60	.45	.27	.20	.19	.30	.23	.41
13, 14, & 15					.70	.54	.35	.30	.19	.19	.09	.23
18, 21, & 24						.80	.49	.50	.37	.43	.45	.55
27, 30, & 36							.72	.70	.58	.53	.46	.54
42, 48, & 54								.82	.71	.64	.70	.62
Years												
5, 6, & 7									.92	.85	.87	.86
8, 9, & 10										.94	.92	.89
11, 12, & 13											.96	.96
14, 15, & 16												.96

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*These scores are the means of standard scores for three consecutive test-ages, e.g., months 1, 2, & 3; 4, 5, & 6, etc., and years 5, 6, & 7, etc. The last level is composed of only two test ages, 17 & 18 years. Each child's score is the average of all tests taken by him for the ages included in that level.

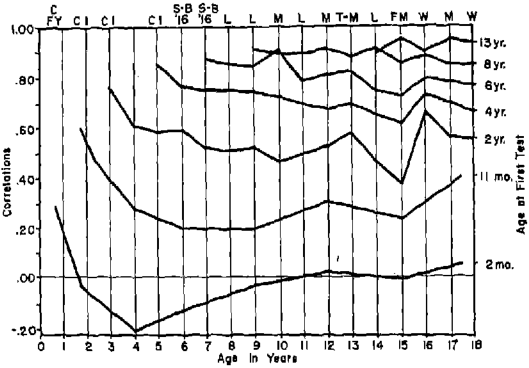

FIGURE 7

Age Curves of Correlation Coefficients between Scores on Selected Initial Tests and Subsequent Tests Given at Yearly Intervals

Figure 7. Table 4 gives the r's for consistency of mental test scores for successive age levels in which each child's Sigma Scores for three successive test ages have been averaged. This particular set of r's, by the use of averages for three tests, eliminates most of the chance variations which occur in single test scores. Furthermore, the use of Sigma Scores eliminates the age changes in variability which would tend to alter the magnitude of the r's. For comparison, Table 5 gives the r's between single test *IQ*'s for ages six through 18 years. Table 6 and Figure 8 give consistency correlations (single test point scores) for the 27 cases who make up a constant sample for a wide range of ages.

From these correlation coefficients we may see the extent to which the children's relative mental status remains constant. It has now become fairly well accepted that the size of a test-retest correlation for *young* children is a combined function of the age of the children and the length of the interval between tests.

The correlation coefficients, as we have pointed out in earlier publications (4, 5), indicate that these children's scores on the tests given before two years of age are quite unrelated to their test scores during school ages. They indicate, further, however, increasing stability of scores with increas-

TABLE 5

Correlations between Mental Test *IQ*'s for Tests Given at Different Ages (6 Through 18 Years)

Age at test	Stanford-Binet Form 1916 7	Stanford-Binet Form *L* 8	Stanford-Binet Form *L* 9	Stanford-Binet Form *M* 10	*L* 11	*M* 12	Terman-McNemar Form *C* 13	Stanford-Binet Form *L* 14	Terman-McNemar Form *D* 15	Wechsler-Bellevue 16	Stanford-Binet Form *M* 17	Wechsler-Bellevue 18
6	.86	.85	.84	.90	.78	.81	.82	.74	.72	.79	.78	.77
7		.88	.83	.87	.82	.83	.88	.79	.75	.83	.83	.80
8			.91	.89	.89	.91	.88	.91	.85	.88	.84	.85
9				.88	.90	.82	.87	.86	.82	.87	.85	.87
10					.92	.90	.88	.92	.83	.88	.86	.86
11						.93	.91	.93	.89	.89	.92	.93
12							.87	.94	.85	.88	.90	.89
13								.89	.95	.90	.94	.93
14									.87	.92	.89	.89
15										.88	.89	.88
16											.89	.94
17												.90

TABLE 6
CONSISTENCY CORRELATIONS BETWEEN MENTAL TEST POINT SCORES AT INDICATED AGES FOR 27 SELECTED CASES

Age at test	Months 6	13	18	24	36	48	Years 7	9	11	15	17	18
Mo.												
3	.35	.02	—.05	—.13	.05	—.03	—.15	.08	.08	—.04	.12	—.03
6		.63	.35	.08	.13	.09	—.12	.04	—.07	—.26	—.04	—.24
13			.60	.47	.41	.23	.13	.13	.02	—.18	.002	—.14
18				.50	.54	.41	.33	.14	.11	—.02	.20	.03
24					.74	.47	.60	.43	.43	.27	.41	.39
36						.64	.53	.55	.48	.33	.56	.40
48							.71	.76	.69	.54	.71	.52
Yr.												
7								.79	.74	.71	.79	.68
9									.90	.77	.84	.80
11										.89	.92	.87
15											.88	.84
17												.79

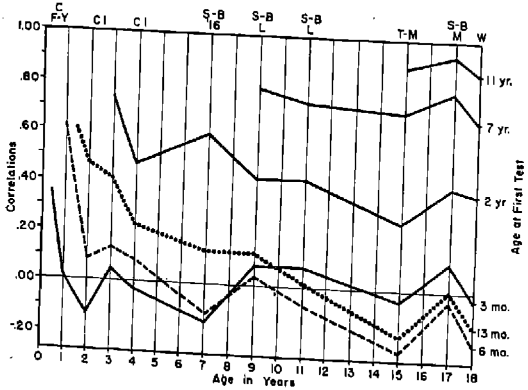

FIGURE 8
AGE CURVES OF CORRELATION COEFFICIENTS FOR A CONSTANT SAMPLE OF 27 CASES

ing age.[11] By two years the r's with tests at later ages hold up fairly well, rarely dropping below .50. The school-age correlations drop off only slightly as the interval between tests is increased for higher age levels. Studies on other children such as those of Honzik (22), Goodenough and Maurer (20), Ebert and Simmons (15), and Anderson (2) show very similar correlational trends.

3. *Correlations between Scores on Different Tests*

It has been suggested (2) that the consistency of the test scores will be affected by the use of different tests at different ages. In very few studies has the same test been given to the same children at all ages. One reason for this is that no test has been standardized for the entire age span. Furthermore, even if something had been named the same test, it would necessarily be comprised of very different items at the different age levels. Especially do the infant and preschool tests differ from the later ones. Perhaps the closest approach to this desirable condition of similar functions in a single testing instrument given to the same children over a wide age range, is to be found in the study of Freeman and Flory, in which the *VACO* tests were used from six through 18 years (a period of relative stability). This study shows individual variations in growth which are similar to our data, even though in the Berkeley Growth Study we do not have this constancy of testing instrument. Three forms of the Stanford-Binet, the Terman-McNemar Group test, and the Wechsler-Bellevue were given at various ages during this same age span.

The effect of changing tests on the Berkeley Growth Study group's relative status may be seen from Table 7. In this table the r's are grouped according to the tests involved. For 12 comparisons between repeats of the same test, the mean of the r's is .89.[12] For 26 comparisons between different forms of the Stanford-Binet the mean of the r's is .87. For 40 comparisons between unrelated tests the mean of the r's is also .87. The lowest r in this last group is .72 between the 1916 Stanford-Binet at six years and the Terman-McNemar at 15 years. It is likely that the age at first testing and

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[11] Honzik's (22) findings that "the magnitude of a correlation between tests varies directly with the age ratio $\frac{CA \text{ at first test}}{CA \text{ at second test}}$ holds up fairly well to about five years. After this age, however, there is much greater constancy than the ratio would predict. See Figures 7 and 8.

[12] Computed by the formula $\frac{(N-3)\,xZ\text{'s for } r\text{'s}}{\Sigma(N-3)}$, see Lindquist (27, pp. 218-219).

TABLE 7
INTERCORRELATIONS BETWEEN TEST SCORES ACCORDING TO THE TESTS COMPARED (SIX THROUGH EIGHTEEN YEARS)

Intercorrelations When the Same Test is Repeated
(Mean of 12 *r*'s = .89)

S-B, 1916			*S-B, L* x *L*			*S-B, M* x *M*			*TMG, C* x *D*		
CA	*N*	*r*	*CA*	*N*	*r*	*CA*	*N*	*r*	*CA*	*N*	*r*
6x 7	44	.87	8x 9	45	.91	10x12	41	.90	13x15	33	.95
			8x11	44	.89	10x17	39	.86			
			8x14	36	.91	12x17	37	.90			
			9x11	43	.90				*W-B* x *W-B*		
			9x14	35	.86				*CA*	*N*	*r*
			11x14	37	.93				16x18	36	.94

Intercorrelations between Different Forms of the Stanford-Binet
(Mean of 26 *r*'s = .87)

1916 x *L*			1916 x *M*			*L* x *M*			*L* x *M* con't		
CA	*N*	*r*	*CA*	*N*	*r*	*CA*	*N*	*r*	*CA*	*N*	*r*
6x 8	45	.84	6x10	46	.90	8x10	45	.89	14x10	36	.92
6x 9	44	.84	6x12	42	.81	8x12	42	.91	14x12	35	.94
6x11	44	.78	6x17	39	.78	8x17	39	.84	14x17	36	.89
6x14	36	.74	7x10	45	.87	9x10	44	.88	11x10	43	.92
7x 8	44	.85	7x12	41	.83	9x12	40	.92	11x12	41	.93
7x 9	44	.81	7x17	40	.83	9x17	38	.85	11x17	39	.92
7x11	44	.82									
7x14	37	.79									

Intercorrelations between Unrelated Tests
(Mean of 40 *r*'s = .87)

S-B, L x *TMG*			*S-B,* L x *W-B*			*S-B, M* x *TMG*			*S-B, M* x *W-B*		
CA	*N*	*r*	*CA*	*N*	*r*	*CA*	*N*	*r*	*CA*	*N*	*r*
8x13	37	.88	8x16	40	.88	10x13	36	.88	10x16	40	.88
8x15	38	.85	9x16	39	.87	10x15	38	.83	12x16	36	.88
9x13	36	.87	11x16	40	.89	12x13	34	.87	17x16	40	.89
9x15	37	.82	14x16	36	.92	12x15	36	.85	10x18	36	.86
11x13	37	.91	8x18	36	.85	13x17	33	.94	12x18	34	.89
11x15	38	.89	9x18	34	.87	15x17	37	.89	17x18	36	.90
14x13	33	.89	11x18	35	.93						
14x15	36	.87	14x18	33	.89						
			S-B 1916 x *TMG*			*TMG* x *W-B*			*S-B* 1916 x *W-B*		
			CA	*N*	*r*	*CA*	*N*	*r*	*CA*	*N*	*r*
			6x13	36	.82	13x16	32	.90	6x16	40	.79
			7x13	36	.88	15x16	35	.88	7x16	41	.83
			6x15	38	.72	13x18	31	.93	6x18	36	.77
			7x15	39	.75	15x18	33	.88	7x18	36	.81

*See footnote 12.

the length of the interval between tests is at least as significant in causing this low *r* as the fact that they are two different tests. It would appear that for this group of children the consistency of their intellectual status relative to each other is very little influenced by the use of these different tests. This is true, even though the *IQ*'s as computed according to the several test norms, are often quite variable.

I. THE GROWTH OF INTELLIGENCE IN INDIVIDUALS

Individual age-curves of intelligence scores, as represented by Sigma Scores (or Stanford Scores) are very informative. In a previous study (5) the Sigma Score curves were presented for all 48 children who had completed the first nine years of the study. From inspection of the curves it was concluded that only a fifth of the group had maintained approximately the same relative status throughout the nine years. The others showed varying types of shifts in status, often consistent in their trends over long periods. While some grew more slowly and others more rapidly than the average, still others had successive periods of rapid and slow growth.

Examples of individual trends for the entire 18 years are shown in Figures 9 to 12, which present the mental scores of four different children in the study. For the purpose of comparing the *IQ* with the Sigma Score, which represents more accurately the interrelations of the children in this study, each child's scores are plotted in two ways. The broken line gives the *IQ*'s derived from the published norms for the tests used. (These charts are drawn to the scale of one *SD* to 15 *IQ* points, which approximates the average, for all the ages, of the *SD*'s of *IQ*'s in this group.) The solid line represents the Sigma Scores, which show the children's status in the Berkeley Growth Study group[13]

Inspection of the curves gives the impression of great instability of scores during the first year or two, regardless of the method of scoring. Usually the *IQ*'s are more variable, but sometimes, especially near one year of age, the Sigma Scores are more deviant. During the ages when the variability of the *IQ* is greatly restricted it is much more difficult to earn deviant *IQ*'s, even though relative to the group a child's score might be outstanding. Case 14 *F* (Figure 9) is an example: at 12 months she was the most precocious child in the study, earning a score three *SD*'s above the group mean (i.e., a Sigma Score of 3.00). Her *IQ*, however, was only 124, which would ordinarily be interpreted as about 1½ *SD* above average. When she was three years old, on the other hand, her Sigma Score had dropped to .80 while her *IQ* had risen to 132. Another case, 5 *M* (Figure 10), shows much greater variability in his Sigma Scores before five years, and in his *IQ*'s after this age. Although both of his curves indicate rapid growth and an upward trend in scores between 18 months and two years, the early retardation was much more marked in the Sigma Scores, and the later acceleration was by far greater in the *IQ*'s.

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[13] The *IQ*'s are all higher than the Sigma Scores after the first few years. This is to be expected as the former are computed from the test norms, while the latter are computed from the means of *MA*'s or point scores for this superior group.

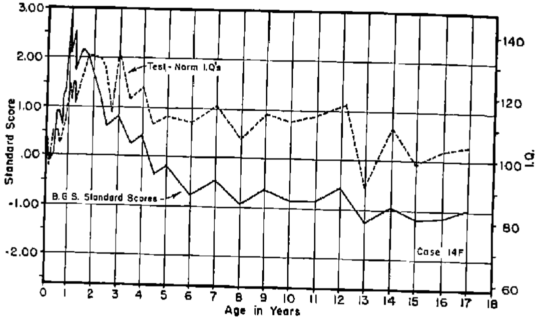

FIGURE 9
CURVES OF THE INTELLIGENCE SCORES OF CASE 14 *F*: THE SOLID LINE REPRESENTS HER RELATIVE POSITION (STANDARD SCORE) IN THE BERKELEY GROWTH STUDY; THE BROKEN LINE GIVES *IQ*'S COMPUTED ACCORDING TO THE DIRECTIONS FOR THE TESTS USED

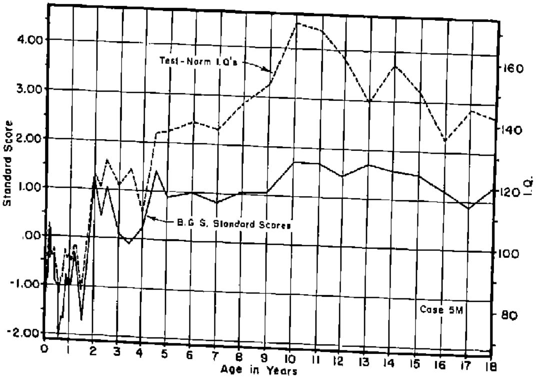

FIGURE 10
STANDARD SCORE AND *IQ* CURVES FOR CASE 5 *M*

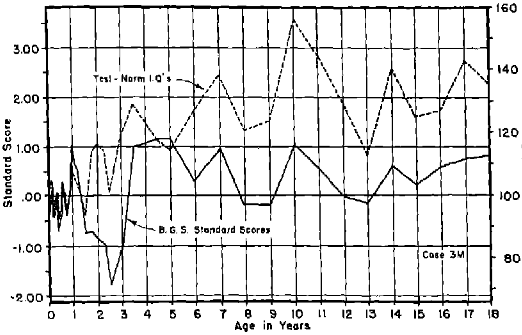

FIGURE 11
STANDARD SCORE AND *IQ* CURVES FOR CASE 3 *M*

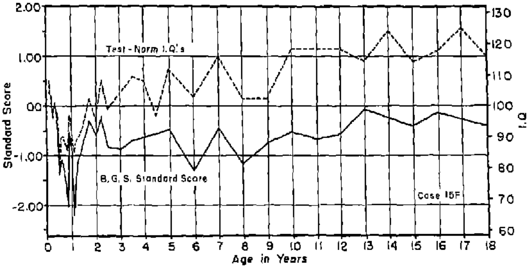

FIGURE 12
STANDARD SCORE AND *IQ* CURVES FOR CASE 15 *F*

Further examination and comparisons of the individual Sigma Scores reveals the normal variations in individual mental growth. We have quantified the individual differences in "constancy" by assigning "Intelligence Lability Scores" to all of the Berkeley Growth Study children. This was done by computing, for each child, the mean and *SD* of his Standard Scores earned over given age-intervals. A child's standard deviation from his own mean is his *Lability Score*. A high score, or large *SD*, signifies greater lability or variation from the child's own central tendency. Data on these scores are

TABLE 8
MEANS AND *SD*'S OF INTELLIGENCE TEST LABILITY SCORES FOR 40 CASES

	Infancy Months 1-21 I (17 test ages)	Preschool Years 2-5 II (8 ages)	School-age Years 6-18 III (13 ages)	Total Span 1 Mo. to 18 Yrs. IV (38 ages)
Means				
Boys	6.78	4.32	3.39	5.46
Girls	6.78	4.19	3.31	5.41
Total	6.78	4.25	3.35	5.44
SD's				
Boys	2.00	1.61	1.14	1.36
Girls	1.73	1.55	.99	1.05
Total	1.87	1.58	1.08	1.22

given in Table 8. For the 17-test period of one to 21 months, the Infant Lability Scores averaged 6.8, *SD* 1.9; for the eight-test Preschool period of two to five years, the mean Lability Score is 4.3, *SD* 1.6; and for the 13-test School-age period of six to 18 years, the mean is 3.4, *SD* 1.1. This is another way of showing that the children maintain their own relative status more closely as they grow older. Both the Lability Scores and the individual differences in Lability (*SD*'s) decrease with age. For the entire 18-year span (with a maximum of 38 tests per child) the mean Lability Score is 5.4, *SD* 1.2. Individual scores range from 12.23 for a boy in the Infancy period to 1.21 for another boy in the Preschool period.

Whether or not a Lability Score such as this will have value in describing characteristics of growth in children, or in differentiating children in any significant way, should be interesting to investigate. A few preliminary comparisons have been made. For example, we found no sex differences in Intelligence-Test Lability at any age-period, the largest critical ratio being 0.24 for the Preschool period.

Intelligence Test Lability has been correlated with level of intelligence at the several age-periods (see Table 9). The *r*'s are all practically zero,

TABLE 9
CORRELATIONS SHOWING THE RELATION OF INTELLIGENCE TEST LEVEL TO LABILITY SCORES FOR 40 CASES

Age at lability score	*r* with Intelligence Level at same age	*r* with mature Intelligence Level*
Months 1-21	—.02	—.005
Years 2-5	—.08	—.14
Years 6-18	.12	.18

*Mean Standard Score for years 16, 17, and 18.

the largest being that of mature intelligence with School-age Lability. This r of .18 is not significant but it is in line with McNemar's (29) finding of small significant relations between the magnitude of the *IQ* and test-retest differences. For the School-age period, the upper Quartile (10 cases) in intelligence has a mean Lability Score of 3.9, *SD*, .84; the middle 50 per cent is intermediate in Lability with a mean of 3.3, *SD*, 1.2; while the lowest intelligence quartile has a mean Lability of 3.0, *SD*, .85. The critical ratio between the means of the first and fourth quartile is 1.16. On McNemar's interpretation, this slight difference is inherent in the methods of test construction, and does not indicate that the brighter children are any less stable in their abilities over a period of time than those whose intelligence is mediocre or inferior. It does mean, however, that in interpreting the scores we should allow for some greater variability of *scores* at the higher levels of intelligence.

There appears to be little tendency for a given child to have a characteristic Lability pattern at all ages. Intercorrelations between the scores earned for the three age-periods are: Infancy with Preschool, .26; Infancy with School-age, .19; Preschool with School-age, —.29. As may be seen from the r's in Table 10, the score for the total 18-year span is determined almost entirely by the Infancy scores, where the lability is so much greater than at the later ages.

TABLE 10
CORRELATIONS SHOWING THE CONSISTENCY OF INTELLIGENCE TEST LABILITY SCORES FOR 40 CASES

Periods compared	r
Infancy with Preschool	.26
Infancy with School-Age	.19
Infancy with Total Span	.97
Preschool with School-Age	—.29
Preschool with Total Span	.38
School-Age with Total Span	.28

Another approach is to select for study those children who are characteristically *labile* or *stable*. For this purpose we have called *labile* the 10 children (25 per cent) with the largest Lability Scores, and *stable* the 10 with the smallest scores, for any given period. Of the 40 children in the study there were four (two boys and two girls) who were *labile* for the total 18-year span and also for two of the three shorter periods. Similarly, there were two boys and two girls who were *stable* by the same criterion. Thirteen children (seven boys and six girls) were both *labile* and *stable* at different periods. For example, a child would be very stable (in the lower Lability quartile) in his intelligence scores for several years, yet at another time he would become labile, with considerable change from test to test (i.e., in the upper Lability quartile). Only six (five of them girls) maintained moderate scores (i.e., in the middle 50 per cent) for all three periods as well as for the total 18-year span.

Whether the four children who can be characterized as generally labile are significantly different in any other respects from the four stable children, or whether these eight in turn are different from the six moderately labile, will have to await a more complete analysis of cases. The differences are not related to adult intelligence level: only one of the four labile children falls in the upper quartile of intelligence; the other three, as well as the four stable children are in the middle 50 per cent. It would appear, from inspection of the individual curves, that a high Lability Score is often the result of a consistent shift in relative mental status during the period covered by the score. Possibly a more fruitful measure of lability would be one which rules out consistent shifts in intelligence level by measuring the deviations of scores from a smoothed curve. As for the present method of measuring lability, it shows that not only are there wide individual differences among these children with respect to the lability of their intelligence test scores, but also that the degree of lability at one stage is no indicator of lability at another stage in the mental growth process.

The impression gained from inspection of the individual Sigma Score curves is corroborated by the Lability Scores. The relatively great lability of scores during the first two years is also evidenced in the correlation coefficients. However, even at the later ages, when the *r*'s between tests are high, some individuals are more steady than others in their mental progress. What is more, a child who had been labile may steady down to consistent intelligence test scores, while another child whose progress had been stable may speed up or slow down, thus increasing his Lability Score.

J. SUMMARY

It has been the purpose of this report to present the growth trends in intelligence for a group of 40 children who had been tested at most or all of 38 testing ages from one month through 18 years of age. Attention has been focused primarily on age changes in variability of intelligence test scores and on individual consistency in relative scores.

Some evidence has been found which indicates that the distributions of intelligence test scores do not exhibit consistent trends in variability during growth. There appear to be periods in which the abilities of children are relatively homogeneous, and others in which there are much greater individual differences. These periods are found in the scores obtained from a number of different tests and investigations, and thus seem to be inherent in the processes of mental development.

It is postulated that greatest homogeneity in scores occurs for a function when it is just starting to develop; that scores are most dispersed when that function is still growing rapidly but when those who are growing most rapidly in the function are not yet mature; and that as the slower-growing individuals reach maturity in the function the differences again become somewhat restricted. Consequently, if the tests are adequate measures of the abilities under consideration, fluctuations in the standard deviations of scores would be caused by the successive (and at times partially concurrent) developing and maturing of different types of intellectual ability.

If these postulates are valid, it would seem well worth while to direct studies, not only toward isolating, but also toward discovering the onset and course of development, of the different functions, or "factors," of intelligence. Furthermore, the tools with which we measure general intelligence should be fashioned with these considerations in mind.

Statistically, in order to increase the constancy of relative mental test scores (and to compare abilities in the same children through periods of time), it is important to use scores which do not fluctuate with the *SD*'s. It is also necessary to rule out differences due to the use of different tests with unequal standardizations. These sources of irregularity have been controlled for the Berkeley Growth Study by computing Sigma Scores (and Standard Scores) from the means and *SD*'s of the point scores or mental ages earned by these children.

The consistency of the mental test Sigma Scores is then studied by means of test-retest correlations, of individual age-curves, and of Lability Scores. The latter measure the extent to which each child fluctuates from his own intelligence level, in tests taken during a given age-span.

By all three methods of comparing, it is seen that children's scores are very labile during infancy, and become gradually more stable. By school age the prediction of the general level of intelligence is fairly stable. However, there are considerable individual differences in lability at all ages. This is true for our Sigma Scores, but when the test-norm *IQ*'s are used there is much wider fluctuation, especially for those children with the more deviant scores. Such deviant *IQ*'s should, in practice, be interpreted with great caution. These data point to the desirability of using some form of Standard Score (or *IQ*'s derived from Standard Scores) instead of the ratio *IQ*.

The high *r*'s between scores on the Stanford-Binet, Wechsler-Bellevue, and Terman-McNemar Group tests indicate that these three tests measure much more nearly the same abilities than would be expected from the children's differences in *IQ*'s. Equivalent scores for these tests, based on comparable case samples would be useful in practice.

Boys and girls were found to be equally labile in their test scores. Children with high levels of intelligence were not significantly more labile than those with less intelligence, in this group.

For the school-age period which is definitely more stable than for younger ages, the children's Lability Scores averaged about one-third of a standard deviation, or roughly five or six *IQ* points. This figure is very similar to those given for earlier studies which emphasized the "constancy of the *IQ*." It must be kept in mind, however, that our Lability Scores are *SD*'s based on 10 to 13 tests per child (for the school-age period), and do not represent the extremes, but the central tendencies for a number of tests. Although many children maintain fairly constant levels of intelligence after six years of age, in some there are wide shifts in mental level. These shifts may occur at any age, and over a wide range of intellectual ability.

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THE DEVELOPMENT AND TRAINING OF HAND DOMINANCE: I. CHARACTERISTICS OF HANDEDNESS*[1]

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A. Handedness Tendencies and Patterns

Every normal person is endowed with two arms and hands which serve for the manipulation of tools and other manual activities. In early life the child apprehends his environment largely through the coöperation of eye and hand. Most persons earn a living through working with their hands, whether in rough labor, highly specialized manual skills, or through mental activity recorded in written symbols. Everyone depends upon his hands for countless services in daily life.

The hand has been described as the instrument of the mind, a tool that surpasses in its flexibility, power, and strength any other tool in existence. Skill in the use of his hands has given man ascendency over natural forces and it accounts for his intellectual evolution, his inventiveness and adaptability. Through the use of his hands man has created other tools for learning and achievement.

The average person has little conception of the potentialities for training and usefulness that reside in his hands. The schools have tended to slight motor training and have given scant attention to improving the manual efficiency of their pupils. This same lack exists after formal school training is over except in industrial plants where workers are trained for specific jobs. As a result, the average person operates considerably below his maximum level of efficiency in manual performance.

1. *How the Hands Function*

The hands execute impulses from the brain by means of nerve tracts which activate the efferent muscles. These reactions may be on an automatic, reflex level or consciously controlled by thought. The latter tend to be more complex activities, more elaborately patterned, less readily habituated or newer than the former. Although organically the brain is structured with two halves or hemispheres which are connected by nerves and muscles to

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[1] References are printed at the end of Part V.

the opposite-sided limbs, functionally the brain operates as a unit and the entire cerebrum is involved in motor responses. Manual habits and adaptations reflect the individual's mental processes and reveal mental and physical anomalies of function.

In the normally sighted person, through a process of mental and physical development, the eyes and hands function coördinately. Oculo-motor control is a prominent feature of dextrous movements and characterizes our most highly specialized manual skills. Even in infancy the eyes begin to guide the hands; by the time adulthood is reached the eye and hand have become a highly efficient team for intricate psycho-motor performance.

2. *Symmetry in Structure*

The human body is constructed on a bilaterally symmetrical plan in certain major features such as the facies, teeth, and jaws, the manual and pedal extremities. One side mirrors the other. In a motor performance such as walking the limbs move contralaterally. This lateral symmetry of the body contributes to balanced motor adjustments. Movements made by the two hands simultaneously are complementary, being made more easily in contrary directions than in identical directions.

Try twisting the hands about each other as though rolling them in a muff. Apparently the same motion is made with both hands. Now keep turning them about each other as before, but gradually extend the arms out in front of the body still making the circular motion. It will be found that the hands are not moving in the same direction, but contrary-wise or in mirror fashion. Contrary-wise movements are easy for the pianist, and are made in many common everyday activities such as changing the hairbrush from one hand and one side to the other or buttoning one's coat.

Although the normal body is bilaterally symmetrical, the one side patterning the opposite side in reverse, some degree of asymmetry or lopsidedness is usually found in facial features, in handedness, and in sidedness generally. Dr. Gesell noted postural asymmetry in children at birth and concluded that perfect symmetry must be rare, indeed. He believes the balance tends to be overthrown even in the intra-uterine stage, and that the two hemispheres of the brain may also be subject to asymmetrical development.

3. *Sidedness of the Organism*

Sidedness is an obvious characteristic of the human organism; but in spite of its obviousness, laterality is a complex feature of human structure and development, and difficult to account for. Both the growing child and the mature adult show sidedness in postures in sleeping, standing, and sitting, as well as in walking, eating, and other characteristic behaviors. Sidedness is a feature of vision: right-eyedness versus left-eyedness, of manual activity and footedness, of chewing, smiling, and possibly of hearing. From birth to maturity lateral orientation becomes more pronounced until the individual is said to be right-handed or left-handed, as the case may be. Eyedness and footedness are less obvious characteristics than handedness, yet laterality in these features is also observed in the majority of mature persons.

4. *Laterality in Handedness*

Nature's economy is shown in specialization of function. The skilled use of the hands is but one illustration of this trait, and the attainment of dextrous manual dominance represents an even higher degree of specialization in motor functioning. Effective motor adjustments require an active hand and an auxiliary hand. Uneven handedness, and complementary manual coördination, with one hand in the dominant rôle, is considered to be practically the only certain test of civilization, and may be regarded as a social symbol.

There are two kinds of manual skill in which hand dominance is a factor: (*a*) Skills performed entirely or largely with one hand alone; unimanual skills such as using a spoon, eating pie with a fork, shaking hands, writing, turning a key in a lock; (*b*) bimanual skills that demand the complementary use of both hands, with one hand dominating. Most handedness tasks, even writing, are two-handed, for the right-handed writer uses his left to steady the paper or to push it along.

5. *The Advantage of Dominant Handedness*

Consistent sidedness is an advantage for without it a person would be "at sixes and sevens" most of the time in his motor adjustments. The complementary functioning of the two hands with division of labor between them makes for economy and efficiency in performance. The person with the more dominant and consistent manual dexterity becomes the more expert artisan in using tools involving delicate adjustments and operations. Smooth team work between the two hands functioning automatically in motor performance contributes to skill. Individuals who have not achieved manual dominance are less effective or may even be handicapped in motor performance. Delay in establishing dominance is unfortunate because it leads to uncertainty, confusion, and awkwardness in motor performance.

Consistent manual dominance is especially needed in our highly industrialized civilization today with its precision tools requiring in some instances accuracy to .001th of an inch. Consider the dexterity needed in everyday household activities such as cutting with scissors, using a can opener, threading a needle, writing, using a key or screwdriver, dialing on the radio, using the telephone; in industry, the use of cutting instruments, the drill press, the manufacture of instruments and equipment such as sewing machine, fountain pen, musical instruments, and tools used in all the arts and crafts.

Differentiation of function and coördination of the two hands in motor performance is achieved through a process of development, learning, and training. It is also a product of social convention which decrees that only one hand should be used in shaking hands, or tipping the cap, or eating in company.

6. *Ambilaterality*

Persons who use the two hands with approximately equal skill are said to be ambidextrous or ambilateral. Many persons claim that they are ambidextrous and exhibit their skill to prove that they can hammer or paint with either hand interchangeably. Some authorities believe that modern man would be better off equal-handed or ambilateral. However, tests prove that the average two-handed person is never very effective in tool using. One-sidedness saves the person from having to stop and think about hand usage. The chief benefit of ambidexterity would be to prevent poor posture and uneven development of the two sides of the body.

Only a genius would have the ability to attain equal mastery of the two hands in a lifetime so as to be able to use them alternately in the same rôles. The artist Leonardo is cited as such a case, but it is said that he became ambidextrous after maturity through force of necessity due to some incapacity of his dominant right hand and arm. He frequently changed hands while painting and wrote mirror style with the left hand apparently to relieve fatigue. For the average person the childhood years would not be long enough to become ambidextrous if it were desirable and there is no practical necessity for attaining this degree of manual skill. For some manual workers, however, it is an advantage to relieve fatigue through alternating the hands.

Most so-called ambidexters are to some extent defective in the use of both hands and are essentially ambisinistral instead of ambidextrous. This subject is discussed at greater length in Part II.

7. *Patterns of Handedness*

To describe a person as right or left-handed represents an oversimplification. Handedness is not a fixed quantity nor are right and right-handedness unitary terms. Handedness is a matter of degree determined by the difference in the skill with which both hands are used. Most people use the right hand for some purposes, the left for others. Every physically normal person is left-handed to some degree. There are different combinations and patterns of handedness in different individuals and even within the same individuals, as Burt (1937), Brain (1945), Koch (1933), Durost (1934), Haefner (1929), Heinlein (1929), and others have pointed out. No one except a one-armed person could be considered exclusively right- or left-handed, and such persons are vastly in the minority in any normal population.

8. *Variability and Consistency in Handedness*

Individuals vary in the degree of consistency they show in dominant handedness. Invariability in handedness is the exception, not the rule. Individuals are neither "right" nor "left" uniformly; usage depends on the function being performed. Some children, for instance, are decidedly left- or right-handed, others not so decided. Everyone shows some specificity in handedness, some persons considerably more than others. A little observation among one's associates proves that many are partially or mixed-handed though they think of themselves as one-handed, or were once other-handed than they are now. Wilkinson (see Selzer, 1933) gave 13 tests of lateral dominance to 250 unselected students and found that only 19 of the students were right dominant in all. People who do not consider themselves ambidextral show variations in such activities as sewing, batting, sweeping, writing, pounding, telephoning, with the right hand leading in some, the left in others.

Downey observed that the percentage of left-handed individuals is not only small but that left-handers are much less consistent and stable in handedness than the right-handed, suggesting that the antithesis is between right-hand unilaterality and ambilaterality rather than between right- and left-handedness. The child is more highly stabilized in his choice of the preferred hand in the upper grades, and as he grows older his preference becomes more fixed, although actually the difference between the two hands is decreasing due to practice.

Koch suggests that handedness has been conceived too narrowly as an entity, operating invariably in one task or situation rather than as behavior that varies with situations and circumstances. According to Burt (1937), left-handedness is not such a definite characteristic as has been supposed: Right- and left-handedness are relative terms, not sharply defined alternatives, mutually exclusive or absolutely opposed. The conventional classification of people as right- or left-handed individuals furnishes little information about their manual skills and habits. To say that a child is left-handed usually means that the teacher has observed the child write with his left hand. Instead of splitting the whole population into two simple categories there are at least a half dozen sub-divisions, as Rife's (1922) classification scheme suggests.

The common tendency is to classify people on the basis of dominance in unimanual performance such as writing or eating because such behavior is more obvious and consistent. To stop there however, would be to ignore the complexity of handedness behavior. There are other phases and patterns of handedness that merit attention. The right hand tends to dominate in an adjustment more frequently in unimanual than in bimanual activities, in "taught" than in "untaught" activities and the unimanual responses show less variability than do the bimanual according to Koch (1933), a result which agrees with Ojemann's (1930) results. Left-handedness proves to be more common when skills other than writing and eating are considered and when bimanual skills are included in the observations.

In studying bimanual handedness tendencies, Ojemann (1930) noted that handedness in the same person varies with the nature of the activity studied. For example, handedness in sweeping is more closely related to raking and shoveling than to batting. It is common for the fork to be used in the left hand; in violin fingering the really dextrous job is done with the left hand even by right-handed persons.

Activities and crafts in which people commonly engage make different demands on handedness as Haas (1948) has pointed out: (*a*) Continuous and almost equal skill in the two hands; (*b*) continuous use of both hands but the skilled part placed in the dominant hand; (*c*) the dominant hand infrequently supported by the non-dominant hand; (*d*) right or left hand used alone; (*e*) greater degree of skill required in the left hand.

Even a normal right-handed person has to learn to use the left-hand for certain skills, e.g., answering the phone with the receiver in the left hand while writing notes with the right. Women button their clothes with the left hand, musicians play the piano and violin with the left. The horseback rider holds the reins in the left hand. Driving a car requires the use of both hands and both feet. The left side of the head is brushed with the left hand.

In some skills such as violin playing and certain sports in which both hands participate, each hand learns a particular rôle which is not interchangeable. The separate rôles are learned from the beginning as parts of the total performance.

As Dr. Gesell points out (1947), the subordinate hand may be slow and awkward or it may be deft and alert.

In bimanual performance the more dextrous hand, whether right or left, makes the more skilled movements and does the finer work in tool using; the opposite hand does the steadying part. The dominant hand also does the part requiring more force and strength or firmer grip. For acts such as carving, sewing, sweeping, and sawing one hand, usually the right, has the major rôle; the other, most often the left, acts as an auxiliary to aid in holding, reaching, stretching, and pushing.

In some instances the division of labor between the hands is more the result of training and custom than of physiological difference in strength or skill as in violin playing. Burt (1937) has pointed out that the difference between the hands is never so great in strength as in speed or skill. This superiority increases throughout childhood until maturity is reached.

Many hand usage patterns recur over and over, day after day, for example eating, writing, and occupational activities. Others are rare or occasional usages in such varying situations that no consistent habits are built for them, e.g., packing. doing a washing, carrying packages and umbrella on a rainy day; a young child picking up toys or building with blocks.

Skills vary in the extent to which performance is stabilized in one hand. In crude, less refined skills, not controlled by social strictures or dictates, e.g., digging, sweeping, eating at a picnic, carrying a suitcase or picking up a bucket of water, variability in performance is more likely to occur with positional convenience a larger determinant. Activities of the unskilled type are more apt to be performed by either hand than the skilled performances.

The greatest consistency in handedness is found in those acts most frequently practiced and most similar to each other in the degree and character of dextrous control required.

People who are right-handed for eating, writing, shaking hands, and other frequently practiced skills use the left hand for random, unpracticed acts, but not if these acts require close eye-hand coördination.

Positional convenience may influence the choice of hand usage when under other circumstances the opposite hand would be used because hand usage is so largely a matter of convenience. When the preferred hand is occupied the opposite hand is used in carrying a parcel or picking up a suit case.

A person who is right-handed for eating, writing, sewing, and throwing noted the frequent times she used her left for random acts such as pouring the tea kettle, jotting down telephone numbers in a phone booth, turning out gas at the stove, screwing the top on a paste tube, watering the lawn with a hose, opening a door, cutting cord with a knife, wiping off a table, because it was more convenient to use the left hand at the particular time.

Determining the consistency in an individual's handedness is a problem for statistical analysis. The conclusion from such studies as Haefner's (1929) is that "hand dominance consists of a small number of basic activities which are common to most individuals who exhibit a particular preference."

Stability and consistency in handedness are not only functions of the act performed but increase with age. A high degree of consistency is frequently found in mature persons whose motor habits are well established.

Durost (1934) found that the relation of handedness to age varied with the different measures. His data seem to justify the popular dichotomy, the assumption that left-handed and right-handed people are somehow different in kind. According to Durost, by definition, a right-handed person is one who uses his right hand predominantly for most of the things which involve a choice of hands, with a converse definition for the left-handed. The data from intensive reliable testing bear out this definition in general and Durost sees some practical value in retaining the popular definition.

Durost's data show that there is a positive association between the degrees of hand dominance that an individual will show on a series of tests, and a substantial degree of consistency in type of handedness shown from one test to another. Consequently, he thinks it safe to dichotimize a substantial proportion of the population into left- and right-handed. Even with highly discriminatory tests he doubts that we would find any genuine ambidextrous cases, although there might be a few cases of discernible difference that had no practical importance so far as limitation in performance was concerned. There may not be such a thing as pure left-handedness, but some persons show extreme or decided left-handedness.

Not only is there considerable consistency in an individual's hand activities but there is some tendency for people to be ipsilateral or consistent in total laterality. Right-handed people tend to be right-sided chewers as anthropometric data show. This is to be expected since we tend to put food in the mouth with the right hand and hence on the right side. Eyedness and handedness also show positive though by no means perfect correspondence, but consistent dominance is less often found in eyes than hands.

Studies of handedness tendencies at all age levels show that right-handedness is a more consistent and definite trait than left-handedness. More left-handers are nearer the ambilateral line as the frequency curves of Sections III and IV indicate. The left-handed are never as strongly left dominant as the right-handed are right dominant.

9. *Variations Depending Upon the Tests Used*

In experimental studies employing analytical tests of handedness the consistency of handedness is found to vary with the tests and measures used. Both Koch and Durost reached this conclusion. For example, Durost found that a target test showed a trend toward more ambilaterality, "treasure" and "escape" tests, toward confirmed right-handedness.

In Koch's study the more elaborate and delicate adjustments proved to be the best indicators of dominant handedness. The more complicated and refined the tests, the more varied were the types and classifications of handedness found.

Furthermore, test results proved to be different from observations of the same acts performed when the individual was unaware of being observed.

10. *Studying Handedness*

The essential problem in studying handedness is to determine the relative skill and dexterity of the two hands and the relation of this skill to hand preference. It is necessary to determine not only which is generally the preferred hand, but the frequency of preferences as compared with the opposite hand. Another problem is to determine how handedness distributes itself in a random population at different age levels on a variety of tests measuring different aspects of the same trait.

11. *The Evolution of Handedness*

Human handedness has a long history. In attaining the upright posture man became highly specialized in th euse of the limbs. The hands were freed for tool using, enabling human beings to become manually dextrous, a distinguishing mark of the species. Manual dexterity, human mentality, and speech developed together. Anthropologists have concluded from studies of stone implements and living arrangements that hand preference has existed since the stone age among all races. The progress of evolution in handedness shows gradual decline in ambilaterality and increasing specialization through the ages. Human handedness may be considered a reflection of the evolutionary tendency in the human race toward increasing differentiation in motor function and refinement in manual skill. Human culture appeared by the time man was able to talk and had become right-handed. Eventually man gained his ascendancy as a tool-using creature through the development of characteristic manual dexterity. Developing handedness and adopting right-handedness apparently proved to have high survival value and was a definite advantage to the race.

The invention of the spear and bow were factors in the establishment of handedness for the highest skill required the centering of dexterity in one hand. Hand dominance in combat no doubt was a factor in survival. Fire-making, an essential tool-making skill in prehistoric times, probably influenced the development of handedness. A nation of tool users has the tendency to become more decidedly unidextrous.

Instruments that require the predominant use of one hand are of recent cultural origin: knives, spoons and forks, guns, revolvers, teacups with handles, doorknobs and accurately fitting keys, screws, screw drivers, scissors, monkey wrench, pens and pencils.

No doubt specialization of handedness has been perpetuated in all cultures including our own because it has prestige value; it is a skill that animals do not possess, that primitive races learn only to a small degree and that idiots cannot achieve.

12. *The Right-Handed Convention*

"How do we happen to be right-handed rather than left-handed?" is a question that has baffled the best minds ever since science began to study man's motor performance. Right-handedness is a cultural and social convention to which most people are trained or find it expedient to conform. For the traffic to move in one way when there is a considerable stream of it is the best expedient. If half the men in the army were right-handed and half left the picture would be bewildering, indeed; efficiency would be impaired and our national defense would be weakened. It was a great convenience for man to establish a consistent "rule of the road" in handedness. For concerted group action a smoother rhythm is possible if all move alike. Man had to develop sidedness to live efficiently in the modern civilized world. He invented or stumbled upon and adopted the convention of right-handedness for greater social harmony.

In an unbiased world, left-handedness would be as common as right-handedness, for the play of chance factors would be equal for the two sides. All would be in confusion. There would have to be two sets of armchairs in college lecture halls, with the left-handed students in continual conflict with the right-handers trying to locate their places. There would have to be two sets of doorknobs, or two sets of doors equally convenient to right and left-handed people. Every department store would have to be stocked with two sets of scissors, golf clubs, scythes, and screws in equal numbers.

Whether there is any sound basis for the convention of right-handedness rather than the left we cannot say. Probably the preference for the right in the dawn of civilization was arbitrary. At all events, right-handedness has continued to be the prevailing fashion down the ages.

Dr. Wile has proposed "helitropism," a unique but highly speculative theory, as an explanation of right-handedness. According to this theory, persons in the northern hemisphere turning toward the sun and following the sun all day in its course would describe a circle to the right. Civilization first developed in the northern hemisphere; the tool makers and highly skilled tool users originated in the north temperate zone; and the right-handed custom became predominant as civilization spread over the globe and the specialized use of tools became more prevalent.

13. *Early Adoption of Right-Handedness*

When human culture first developed man was both right dominant and could speak. From earliest recorded history right-handedness has prevailed throughout the world.

Archeologists have found that most ancient implements were designed for the right-handed, but among fossil remains some tools are always found for the left-handed.

Although the proportions of right- and left-handed implements in the Stone age were nearly equal, a slightly greater proportion of right-handed implements is always found. Left-handedness was much commoner then than it is today in Western civilization. There is some evidence that in prehistoric times left-handedness ran as high as 33 per cent contrasted with the 4 or 5 per cent found among adults in modern times. Studies of skeletal remains also prove that ancient people were right-sided chewers.

Most experts agree that the strong tendency toward right-handedness is of social origin, a custom probably started in religious ceremonies or in military organization as the weapons used required more manual skill.

There are frequent references in the Bible to handedness in military action with special mention of the rare left-hander.

The advantages to be gained through uniformity in sidedness must have been realized when man first began to engage in massed concerted action in any large numbers. The system became reinforced and finally established as a social custom carrying considerable prestige. The deviate was punished or ostracized.

In Homeric times the shield held in the left hand protected the heart, while the right hand held and thrust the spear. Right-handed warriors could most directly attack their adversaries on the heart side of the body. All army regulations today are heritages of spear-hand and shield-hand usage. As someone has said, "Zenophon is still in command of the army."

Left-handedness is proportionately low among civilizations in which the common people learn to read and write, shake hands with one hand, eat with silverware and are employed in industries which require intricate tools.

In any era or culture where the population greet each other by bowing instead of hand-shaking, where there is social indifference toward eating customs or little use of tools other than fingers for eating, where the general population is illiterate there is more tendency toward ambidexterity. (Wile, 1934).

14. *Handedness as a Developmental Trait*

The human infant at birth is neither right- nor left-handed, but fairly early in life the child begins to show bias and preference in handedness until by the time maturity is attained 95 per cent or more of the population exhibit a predominant right-handed tendency. This developmental process parallels evolutionary trends in handedness in human culture. Manual development in all its phases is a product of growth and behavior; it is a learned characteristic. The handedness habits the individual begins to show in early childhood becomes the pattern of habits he is likely to have as an adult.

As Dr. Burt (1937) points out, with age the individual shows increasing self-consistency due largely to strengthening of habit through learning and social influences. Change takes place from birth to maturity in the direction of specialization of handedness and conformity to social convention in the hand preferences shown.

Section III describes in greater detail the developmental process in the attainment of handedness.

15. *Trends in the Experimental Study of Left-Handedness*

In the past, mysticism has been associated with left-handedness and speculation has run ahead of objective fact-finding. Popular impression gained from freakish cases tend to distort the true evidence regarding the nature and causes of left-handedness. When phenomenon are complicated people tend to explain them in terms of vague theories, whereas fact-finding research would suggest simpler explanations. The specialists in this field have tended at times to seek facts that fit their theories rather than the other way around, or to doubt or overlook the facts that fail to fit their theories. Most of the "scientific" studies still suffer from an insufficiency of cases because left-handedness is comparatively rare, handedness is judged in terms of limited criteria, few studies report sufficient observations for statistical reliability, too often sweeping generalizations are based on cases in a narrow age range, developmental trends in young children have been overlooked, the learning capacity of the individuals studied is not indicated, and the supposition that handedness is entirely a matter of heredity or under the control of "cerebral dominance" clouds the worker's interpretations of clear-cut facts. Training factors are disregarded, and generalizations are based on too limited evidence.

Developmental studies are rare. Until recently, few infants have been accessible for intensive study, yet it is evident that handedness habits are formed in early childhood. The chief defect of some otherwise good studies is that they are "piece meal" and do not give a comprehensive picture of the handedness as developmental learning.

As Durost (1934) indicates, the tendency has been to assume that all measures of handedness are positively correlated to the point of reliable prediction, to measure handedness of a small sample by crude methods of unknown reliability, and to generalize from these as to the nature of the relation between handedness, reading, character, emotional traits, school success, interests and other characteristics of behavior. There is need for better genetic and controlled studies, more reliable testing, broader sampling, more complete developmental records.

Koch (1933) points out that we need to know much more about people's manual habits than we do at present. A better job must be done to explain the learning process, the rôle of habit formation in eye and hand dominance, how these skills are acquired, how early and how permanently. All phases of laterality, eye-hand coördination and posture must be studied, not handedness alone.

The older point of view was represented in Jones' (1918) assertion that we need to establish standards for "born handedness" and "adopted" handedness, and that the next problem is to find and classify children into three groups, pure right-handed, left-handed, and transfers so that we can say with certainty whether the child should be changed over or not. The more modern point of view is that we need to study handedness behavior in the developing child and take better account in the process of accidental and direct training factors.

Through the years some of the experts have been on a hunt for tests and indications of "native handedness." What they should seek, modern workers urge, are reliable methods of determining the handedness and sidedness characteristics of representative individuals during their development from birth to maturity. Today there is more emphasis on cultural influences in human development and more attention to educational factors in human growth. Progress has been made in anthropological measurement and more reliable studies have been made of child development in motor skills through cinematographic records.

16. *Reports of Published Studies*

In 1923 D. K. Moehlmann listed a bibliography of 170 items on the topic of left-handedness. Parson listed nearly 600 items of scientific research in 1924. In a book on this topic Wile (1934) canvassed the entire field more widely than any of his predecessors, listing over 700 topics in his bibliography. Haefner (1929) also has a comprehensive bibliography. Burt (1937) devotes 89 pages of his book on the backward child to a detailed consideration of this topic. Original studies have been made by Koch (1933), Durost (1934), Downey (1933), Selzer (1933), Haefner (1929), and others. Downey's study of 1933 is the most recent, comprehensive summary of data on handedness. Hildreth's article in the *Encyclopedia of Educational Research* (1949) is a convenient briefer summary of scientific research on the topic. A bibliography of over 250 titles will be found at the end of this publication.

B. THE EDUCATIONAL AND SOCIAL SIGNIFICANCE OF HANDEDNESS

There are a number of reasons why handedness deserves attention in child training:

1. Achieving handedness is essentially a learning process involving habit formation, spontaneous reactions, postural adjustment, expression of choice, and responding in social situations.
2. The learning and adjustment process begins in infancy and is not completed until adulthood.
3. Emotional conflicts may arise due to the type of training the child receives.
4. There are physiological, neurological, and motor factors to be considered in handedness.
5. Individual differences are very great.
6. Conflicting theories influence training practices.

7. The question of whether handedness is hereditary or environmentally conditioned has never been satisfactorily answered.

8. There appears to be a connection between handedness and speech, as well as between handedness and learning to read, write, and spell.

Dr. Gesell believes this phase of growth is so important that it should be included in every clinical examination.

In this industrial age with greater demands being made on manual dexterity and with greater liability to manual incapacity, training the hands for fullest performance becomes a matter of great concern to employers. All clinicians, psychologists, and vocational counsellors should be prepared to give advice on this subject.

1. *Attitudes Toward Right- and Left-Handedness*

The fact that most children with early left-handed bias are weaned over by the time they reach maturity suggests that parents and teachers and the social world attach more prestige value to right-handedness. For reasons already given above, following the "rule of the road" is approved, the opposite strongly disapproved. Right-handedness is emphasized in all cultures for its social value. The "strong right arm" is associated with legendary heroes. Ever since courts were established the right hand has been required for oath taking. In English and German, both "right" and "recht" are applied to handedness and also express the idea of behavioral rectitude, right-handedness being synonymous with "doing right." Magic and luck are associated with right-handedness.

Over a hundred adults who were asked in a questionnaire whether they would prefer that their children be right- or left-handed responded to the question as follows:

1. Would you prefer your child to be right-handed?
    - *Yes*—99, or 97.7 per cent
    - *No*— 3, or 2.94 per cent
2. Would you prefer to let the child work it out for himself?
    - *Yes*—57, or 58.62 per cent
    - *No*—42, or 42.42 per cent
3. If the child showed a left-handed tendency would you
    - *a.* Help him shift to the right hand?
        - *Yes*—73, or 73 per cent
        - *No*—27, or 27 per cent
    - *b.* Help him to become a better left-hander?
        - *Yes*—40, or 40.81 per cent
        - *No*—58, or 59.08 per cent

2. *Prejudiced and Discrimination Against the Left-Handed*

Prejudice against left-handedness has persisted since earliest times. All the references to left-handedness in the Bible have unfavorable connotations. The word "sinister" with its unsavory implications is of Latin origin meaning "left." The French terms "gauche" meaning "left" and "gaucherie" have come to mean "clumsy." The word "left" is of Anglo-Saxon origin meaning originally "weak" or "broken," akin to "lopt" or "lopped."

Sometimes prejudice in past eras has gone so far as to suggest that left-handedness is immoral or abnormal. The Hexe in Germanic mythology made the sign of the Cross with the left hand, according to an old German tradition. In the seventeenth century, left-handedness was regarded as an aberrations from the divine plan of nature. The left hand has been called the sick hand, and Lord Chesterfield warned against left-handed behavior. Left-handedness was held to be a mark of ignominy and disgrace. Are the left-handed inferior? was a question asked in an early day. The belief was widespread that they were because left-handedness was observed to be associated with other bodily and mental defects.

Some left-handers are ashamed of the condition and try to conceal it. A woman apologized, "I'm always so embarrassed over my left-handedness. It gets in other people's way at the table." In many trades there is prejudice against the left-handed workman.

It is natural that popular prejudices and taboos of this sort arise, for anything that is difficult for the common person to understand or that characterizes the small minority tends to be unpopular. Left-handedness suggests non-conforming behavior to the person who prefers to "go with the crowd."

The prejudice against left-handedness is so strong and life is made so inconvenient for the left-handed that the vast majority of individuals become right-handed in the skills that affect one's social and vocational success.

Infants tend to be equal handed during the first few months of life, but by the time maturity is reached at the close of the adolescent period less than 5 per cent are still dominantly left-handed. This means that between 40 and 45 per cent of all people in highly civilized countries are subjected to influences that train them away from left-handedness.

The taboo is stronger for some forms of behavior than others; it varies in different times and cultures, and there is wide difference in attitude shown by persons of varying background and culture. Shaking hands, eating, and writing with the left hand is more strongly banned than carrying a bundle or combing one's hair. The left-handed writer may be ridiculed but not the child who takes off his cap with the left hand.

Chinese calligraphers at the United Nations headquarters report that left-handedness is far less common in China than here. They believe this is due to the greater strictness of oriental parents in correcting the trait. To the Chinese left-handedness is an exhibition of waywardness or departure from convention which is traditionally frowned upon.

3. *Changing Attitudes Toward Left-Handedness*

The earlier prejudice against left-handedness has tended to relax in recent years. Parents and teachers are not so concerned about changing over all "lefties" to right-handedness as they were in the Victorian era or even 25 years ago. Social pressure to force children to conform to conventions was stronger 50 years ago than it is today, when failure to comply with adult authority was considered perverseness. The child who made special effort to conform, e.g., to change from left-handed to right-handed writing, was considered to have strengthened his will power. Not only the home but the school stressed conformity to authority.

The number of young left-handed children has been increasing within the past 25 years, as the data in Section II indicate. The chief reason may be that home and school discipline have relaxed. At home children are given more liberty to develop their motor skills naturally through free-play activities and parents are more indifferent in the matter of handedness. With fewer children in the home the child is more highly valued and his own wishes are consulted and followed more in child training. The new emphasis on natural child development, permitting the child to make his own choices, tends to give the child more freedom in thought and action from his earliest years.

Left-handedness is no longer considered harmful or morally wrong. The child may even be encouraged to develop any left-handed bias he shows on the assumption that it is hereditary, "He was born that way." Parents are warned not to interfere with the left-hander's tendencies, and teachers are warned that the child should be left to work out handedness for himself, that it is wrong to "interfere with nature's plan." The freer school program with more opportunity today for self-expression and hand work tends to encourage self-choice in handedness.

One group of left-handed adults has advocated an Association for the Protection of the Rights of Left-handers. They believe they should be permitted to take the oath of office with the left hand, buttons should be reversed for them, and musical instruments should be specially constructed to fit their patterns of handedness.

4. *Advantages of Right-Handedness*

There is an advantage in the early formation of right-handed habits for the performance of the most common everyday activities according to Kerr (1920), Burt (1937), Durost (1934), and many others. A person who is left-dominant is by no means the equivalent of a person who is right-dominant, though reversed. The right-dominant person compared to the left-handed is:

1. Usually much more strongly dominant.
2. Not nearly so apt to be ambidextrous.
3. Better in writing.
4. Less apt to be mixed eye-handed, that is, dominant in the eye opposite to the hand.
5. Less apt to have reading, speech, and spatial orientation difficulties.
6. Less apt to be clumsy in motor coördinations.

The left-handed individual belongs to a minority group. He is surrounded by right-handed individuals and moves and works in a right-handed world. All teaching of motor skills and most precision tools, our gadgets and equipment for everyday living are right-handed. There is scarcely an activity or a sport that is free of handedness bias.

Things about the household are arranged for the right-handed: doorknobs, egg beaters, scissors, sewing machines, gramaphones, pencil sharpeners, scythes, golf clubs, screws, keys, water faucets, gas jets, light switch. The right-handed world offers obstacles for the left-handed: latches on casement windows, can openers, cork screws, cafeteria and classroom chairs, pencil sharpeners, automobile gear shifts, painters' palettes, sewing machine wheel. Tools are made for the right-handed.

5. *Left-Handedness and "Two-Handedness" as a Motor Handicap*

Most experts consider the double sinistrality that usually characterizes the left-hander as a motor handicap to school children and to adult workers in the mechanized world of today. The left-handed individual tends to be a slow learner in the motor realm; he is clumsy and awkward in sports and motor performances. The left-hander is usually less successful in the majority of performance with the left-hand than the right-handed are in the same activities. The operation of a circular saw by a left-handed worker is awkward and difficult. One needs to handle the automobile emergency brake with the right hand. The left-handed ball player finds it difficult to buy a glove to fit his right hand so that the left is free for throwing. Often left-handed tools and instruments don't exist. Where is a left-handed monkey wrench to be found? Who has ever seen a left-handed scythe? It is uneconomical in industry to make instruments for the small proportion of left-handed individuals and limited space facilities would not permit their installation.

A college dean who has been highly successful in intellectual and academic achievements reflected on his left-handedness as follows: "It was very awkward growing up left-handed in a right-handed world. I was forced to write with my right hand, but kept almost all other skill with the left. During youth I stuttered badly and I have never been able to achieve skill with my hands. I always have to call in a handy man to repair anything, no matter how simple. My salmon fishing reels all have to be left-handed."

Not enough is said about the difficulties of left-handed people, according to Miss *X*, a dress designer, who broke her right wrist at three and thinks this circumstance accounts for her extreme degree of left-handedness. According to her report, she has never had any trouble with speech, but is clumsy. She cannot drive a car or perform motor skills smoothly because she must always stop to think about orientations. Now she has learned "clockwise" and "counterclockwise" and finds that this helps somewhat. Her father got a permit from the state department when she entered first grade in an Iowa school for her to write left-handed and each year she brought this permit to the school to present to the new teacher. Her patrons in the dressmaking establishment are in terror because she always appears so clumsy with the shears in her left hand. But in learning to knit as a mature adult she had no trouble learning the skill right-handed. In fact, there was no one about who could teach her any other way.

In one experiment the left-handed children in the group had considerably more trouble than the right-handed with jig-saw puzzle solving. One of the children was doubly-sinistral and very awkward in all her movements. She fumbled in attempting to open the room door and has had trouble with reading, writing, and spelling since the first grade.

In sports requiring a high degree of precision such as tennis the greatest players are right-handed. Even the left-handed ball player is not always at an advantage. Left-handed writing is slow, awkward, and sometimes illegible. Left-handed recruits are slow in learning new skills. The left-handed individual may be handicapped both on account of mechanical inconvenience and the emotional consequences of spatial confusion. Slowness, indecision, and fatigue show up in changed-over cases. Even the left-footed individual may be a hazard in the dancing class. Amputation cases, formerly left-handed are said to become more conscious of their left-handedness than any lack of skill in general. This is because an entire set of habits must be changed.

Continued interference with left-handedness, if not direct training away from it, accounts for the fact that the left-handed acquire less skill than the right-handed in corresponding acts.

6. *The Left-Handed at School*

Left-handedness can be a serious problem at school because classroom physical arrangements are set up for the right-handed; the lefties are uncomfortable in one armed chairs, ink wells are on the right side of the desk, lighting arrangements all favor the right-handed. Teachers are ill-prepared to deal with the left-handers. These children have motor difficulties; they tend to collide with their classmates, have difficulty in learning to write, and may develop speech and behavior problems if their difficulties are not understood or are wrongly handled. In one school all the pupils in the lower grades are required to learn to write with the right hand because the upper grade seats have right-handed arms and upper grade teachers expect the pupils to be able to use these seats.

The left-handed child starts with a conflict because he is forced to move in the direction contrary to that which seems natural for him, to make the opposite motions from those he sees the other children making and the opposite of the teacher's directions (Figure 1). Since most teachers are right-handed the pupil who must learn motor skills chiefly by imitating the teacher is apt to have trouble. One left-handed teen age pupil had trouble learning to play the drums because the class was large and the teacher demonstrated only right-handed drumming. The school-entrance period is critical because of the many new situations that are met all at once. The child who shows

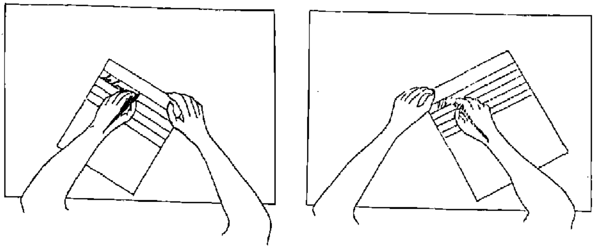

FIGURE 1

decided unilaterality throughout seems to hold his own better in school than the non-established or inconsistent child.

A study of shorthand students (Dell, 1941) showed that the left-handed students received lower marks than the right-handed. Apparently the tendency toward ambilaterality among the left-handed group interfered with the coördination needed for speed. Wittenborn (1946) found that among college students the tendency to use the left hand presented a slight but consistent handicap.

7. *Developmental Difficulties Associated With Handedness*

Case records furnish evidence that inconsistent hand dominance, mixed laterality, delay or difficulty in establishing manual dominance, or conflicts due to efforts to change dominance in habituated skills can cause motor handicaps and serious difficulties in social adjustment. Resistance, negativism, stubbornness, tension, and nervous instability are observed in children who are late in establishing dominance or whose handedness has been partially converted. Left-handers are handicapped in varying degrees in sports and in their vocations. There is a relationship between certain laterality characteristics and deficiencies in development of speech as well as in learning to read, write, and spell. All of these skills involve complex motor coordinations and depend upon conscious thinking processes.

Delay in the establishment of dominance at a normal age between three and six, and unwise training may also be responsible directly or indirectly for behavior disorders and certain neurotic trends. Some of the difficulties of semi-converted sinistrals are: awkwardness, poor muscular coördination, irritability, restlessness, slow thinking, confusion, muteness, slow speech, stuttering, mirror writing, irritability, feelings of inferiority, and negativism (Burt, 1937; Dearborn, 1931; Durost, 1934; Orton, 1937; Wile, 1941).

Dr. Wile noted that even in temporary conversion, as in fracture cases, emotional disturbance is often aroused by the required shift in handedness, there is some impairment of speech, a transitory stammer or mirror writing. The reason is that such a shift involves considerable readjustment in coordination. The experience is awkward and upsetting.

The social aspect of handedness creates problems. In modern life one hand alone is used in eating with silverware or in shaking hands. This puts a strain on the young child who would prefer to use either hand longer than he is permitted. Interfering with learned skills tends to arouse emotional resistance and to produce nervous symptoms. A boy of 12 stoutly refused to attend a family dinner party unless he could sit at the right end of the table so that his aunts would not criticize his left-handedness.

The symptoms of misery, discomfort, and neuroticism tend to become exaggerated in the adolescent years. Tics, habit spasms, and odd mannerisms may appear, the signs of temperamental instability. The fact that some left-handers are ashamed of the trait and try to conceal it as much as possible has an unfavorable effect on their personality.

A well-known writer reports that as a child he was left largely in the care of an inexperienced nurse maid whose motto was, "Anything for peace." He says that in early childhood he had temper tantrums and showed considerable contrariness. He suffered from exaggerated night terrors and anxiety bordering on neuresthenia until well along in childhood. He attributes his atrocious handwriting which was a constant source of friction between himself and his father to the fact that he was naturally left-handed, but was forced to write with the other hand. At 20 he wrote with the unformed hand of a boy of 10; the writing was not only childish but virtually illegible. He was also backward in spelling and had marked distaste for anything associated with school. He says he was hopeless at cricket which he played left-handed and he even hated watching the game. Later a celebrated doctor advised him to learn to fence with the left hand. He also disliked anything connected with machines. His childish difficulty in pronouncing certain consonants was considered by the family as "downright original sin."

Another case is that of Miss Y. who adopted the "crooked wrist" writing position in early childhood, but she is so much ashamed of her left-handed disability that she tries to avoid writing in anyone's presence. Forcible efforts to "change over" caused her so much emotional strain that she attributes her failure at college to this problem.

A business man who is a changed-over, left-handed case says that he attributes all of his difficulties in adjustment since childhood to enforced shifting and subsequent failure to settle on either the right or left hand for dominant performance.

Wile and Davis (1941) selected 100 problem cases at Mt. Sinai Children's Clinic ranging in age from five to 12 years, of normal *IQ*, and analyzed the problems they presented. The problems were: aggressive and submissive behavior, tics, speech defects, and enuresis. Attendant problems were sibling rivalry, infantile position in the family, and difficult school adjustments. Thirty-three per cent of the cases were found to be converted sinistrals. Fifty-nine per cent had mixed eye-hand function. Thirteen per cent were right-eyed and left-handed. Forty-six per cent were left-eyed children using the right hand.

Burt (1937) noted a greater incidence of left-handedness among these children who are temperamentally neurotic. Left-handedness is commoner among resistant children, those who are not submissive. Again and again in Burt's case summaries, the child is described as stubborn or wilful if he presents a history of left-handedness or is inconsistent in handedness.

Durost (1934) found in administering his battery of tests that anything calling for relatively fine coördination with the non-dominant hand resulted in such a low degree of success compared to that achieved with the dominant hand for the same task that emotional blocking occurred. This seemed especially true of children with low intelligence.

In a survey of adjustment difficulties, Steinbach (1933) observed handedness to be a factor in 7 per cent of the boys' cases and in 5 per cent of the girls'. Among 160 problem and non-problem observed by Castner (1939), 54 per cent of the problem group and 31.5 per cent of the non-problem group proved to be sinistral. Among the left-handed and impartial-eyed cases were more children who were retarded in reading.

Among 70 adult psychopaths observed by Quinlan (1930), 37.1 per cent were dextral and 54.1 sinistral or partially sinistral.

8. *Consequences of Enforced Shift-Over*

Experience proves that both children and older people can learn new skills with either hand regardless of accustomed hand usage without experiencing any emotional upset. The nervous troubles ascribable to handedness arise in the childhood years when motor development is relatively immature and all sorts of new adjustments are being learned.

There are certain children who make the shift from left- to right-handedness with little difficulty, giving the impression that changing over seems easier than it really is. These children are young and without accompanying handicaps. Some of them have made good adjustments in performing all one-handed skills with the left hand except for eating and writing in which they are right-handed. But there are many other children who become left-handed in the early years and then develop negative resistance when they are forced to change. Children are put on the defensive when they are continually reminded to use the other hand. Coercion adds to the child's confusion. In some cases attempts at conversion are only partly complete because drill and punishment have had only partial success. Nervous strain and other ill effects may result from unsuccessful attempts to "change over."

Burt (1937) notes that tactlessness on the part of the teacher doing the retraining is usually the cause of the resulting instability. Daily nagging engenders a state of continual nervousness and worry. Harsh methods of correction intensify the child's secret shame at being different from his fellows. Mental confusion results from the clash between the old habit and the new requirements so suddenly and harshly imposed. Difficulties arise when the individual must make conscious effort to make new adaptations or to submit to rigid restrictions. The retraining often comes too late when the child is already well-settled in his manual tendencies.

There are both well-adjusted and poorly-adjusted left-handers, but the reasons for the difference are not always easy to fathom. Two children, one a boy aged 10-3, the other a girl aged 10-9, were enrolled in the same school within the same week. The boy, of normal intelligence, a left-hander who had been poorly trained at home, had a long history of behavior difficulties. The girl, with a superior intelligence rating, coming from a superior home, was also left-handed, but she had made excellent school progress, preferred to read adult books, had recently won an essay contest, and showed superior personality adjustments all around.

According to Orton, many persons show mixed-sidedness, yet have no difficulty in learning either complex motor acts or spoken or written language. The training methods used account for the differences in adjustment. Sinistrality may be but one symptom of the individual's maladjustment rather than a major cause of personality disturbance.

(*To be continued*)

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THE DEVELOPMENT AND TRAINING OF HAND DOMINANCE: II. DEVELOPMENTAL TENDENCIES IN HANDEDNESS*[1]

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A. THE EARLY CHILDHOOD PERIOD

The young infant's motor responses are incoördinated and not yet under voluntary control. Handedness cannot appear until the motor apparatus matures and the nerve fibres that conduct to the muscles are developed. Consistent sidedness is shown only when the child learns motor coördination, when he can make perceptual distinctions and respond to the cultural clues in his environment. The development of handedness represents a complex behavior pattern.

The first controlled use of the hands in infancy is extending the hands for an object, grasping it and carrying it to the mouth or manipulating it. In earliest infancy the physically normal child is bilateral. The emergence of hand dominance is a developmental sign during the early childhood years. As Dr. Gesell points out, it is a physical advantage for the infant to use one hand, e.g., in attempts to pick up small objects, for by turning the body he can reach farther.

From seven to nine months of age most normal children begin to show some consistent preference for one hand over the other, but the difference is slight and does not become pronounced until the child is about three years of age. Right-handedness is shown earlier than left-handedness according to data from studies that are reported later in this section.

Individual children show marked variability in the time of attaining established dominance and they vary in the degree of skill and preference they show in the early growth period. Dr. Orton commented on the striking lack of stability in the hand preferences that younger children show. He found that young children sometimes shift spontaneously from left- to right-handedness without evidence of external training. This occurs most often between the ages of two and three or six and eight.

Individual histories of infants show that right-handedness which has

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[1] The references are printed at the end of Part V.

gained the ascendency by the end of the first year tends to be checked while the child is learning to walk and to become reinstated again when he begins to feed himself. This is understandable in view of the amount of right-handed conditioning the child receives before he begins to walk, then his need for more equal use of both hands for balance while learning to walk. He returns to right-handedness while learning to feed himself.

The young child begins to display handedness as soon as his manual activities demand more sustained attention and precision, but up to the age of three he has relatively little need in his daily activities for dexterity specialized in one hand.

In the development of handedness the child's learning tasks are two-fold: first, to learn the coördination of the two hands in bimanual acts with one hand subordinate to the other, and second, to achieve greater consistency in the use of the dominant hand.

At first infants do not use both hands together well. As their development progresses, they learn to use both hands in complementary fashion and gain more dexterity in assigning major and minor rôles to the two hands. With further maturation and learning comes greater specialization in the use of the hands and division of labor between the two hands for bimanual skills. There is also an increase in the efficient use of one hand alone. Right-sidedness becomes noticeable between the 12th and 24th months of life; left-handedness appears later.

During this early growth period control of the eyes outdistance control of the hands. In fact, from the first months of life, hand usage is initiated and controlled by the eyes. According to Dr. Gesell, lateral posture of the head may predispose the infant to regard the activities of one hand more than another. The first eye-hand coördinations may help to determine the dominant hand.

1. *Genetic Research in Hand Dominance*

Increased opportunities for the scientific study of infants and preschool children and refinement in observation techniques has brought to light new evidence concerning the development of handedness during these early years. Experimentation with children of this age is always difficult to control because of social pressures and parental influence that are determining factors in preference. Even "scientific" parents have difficulty in avoiding bias in hand training while making observations in the early growth period.

There are few tests that are sensitive enough to detect hand preference in infants and a long succession of observations is needed to establish the facts. Positional conditions at the time of the test or observation may affect results. In testing infants it is necessary to differentiate between strength and dexterity.

Casual observation is of little aid in infant studies because highly refined techniques are needed to detect the slight and subtle indications of manual preference and dexterity; furthermore, growth is taking place so rapidly that frequent repeated measures and cumulative observations are needed to delineate the changes that ensue.'

2. *Data from Handedness Studies in Infancy and Early Childhood*

A summary of the most reliable and comprehensive studies of infant development in handedness will serve to indicate trends in growth during the earliest period of life.

In the first 30 days of life the tendency for the baby to support its full weight by clinging for longer or shorter periods was used as a test of handedness by J. B. Watson (1919). No steady predominance in the use of right or left hand was shown. The early coördinations seemed to form as readily with the right hand as with the left. Watson also tested 20 babies, aged 120-160 days and found no definite tendency toward preference in either hand.

Gieseke (1936) summarized the data for early infancy published by H. H. Halverson and H. S. Lippman. Halverson, in studying prehension in infants, found that hand preference in touching the cubes alternates with age up to 36 weeks and then favors the right hand at 40 weeks (about nine months) and remains with this hand at 52 weeks (12 months).

Lippman (1927) found in a study of acceptance of objects by infants that at four-and-a-half months the right and left hands were used with equal frequency. From this time to 12 months there is a gradual increase in the tendency to use the right hand, culminating in a 70 per cent use of the right hand at age 12 months. Lippman gives a table and chart showing the tendency toward increasing right-handedness in infants from the age of four to 12 months.

Voelckel (1913) reviewed the scattered literature on children under a year of age published before 1913. He cited a study by Arnold who did not find any differentiation in hand usage until the eighth month. Another worker noted that by the age of nine months one hand is preferred in 60 per cent of the cases.

Voelckel (1913) tested 52 children aged three-and-one-half to 17 months. The test was reaching for objects equidistant between the two hands. The tests extended over several days until each child had had about 50 trials. He found no difference in the use of right and left hands earlier than seven months of age, but increasing differentiation from that time on. At seven months the first of his 52 subjects showed right dominance. Noteworthy in all cases was the tendency to grab with both hands. In the second quarter of the first year only one infant did not need to grab with both hands, in the third quarter, seven, in the fourth quarter, 15. In the second quarter the number of left- and right-handed choices was equal. At age seven months superiority of the right hand was shown and it increased with each month of age. By the age of 11 months the hight hand grabbed more than seven times oftener than the left.

Gieseke (1936) studied the laterality of infants, some of whom were observed during the first few days of life. She concluded that hand differentiation is shown throughout infancy, judging from the comparative amount of spontaneous activity of the two hands. In the infants she observed dominance became more pronounced during the later months of infancy and there were frequent transfers in dominance between seven and 10 months of age. Individual differences were much in evidence. The non-dominant hand tended to be used for purposes of support. Gieseke reports that six out of 17 or 35 per cent of the infants showed more left dominance than right.

Lederer and Redfield (1939) found that right- and left-handed cases were evenly distributed in a sample of infants between six and 11 months, whereas in another sample between 12 and 20 months old there was a predominance of right-handed cases. This fact suggests that development toward right-handedness is taking place between the first and second year of life, the time that self-feeding begins. Lederer and Redfield found that changes from left-handed status occur more frequently than changes from right. They concluded that social factors, direct and indirect teaching, are influencing handedness behavior by the second year of life. Socially favored items ranked highest among the right-handed responses.

Gesell and Ames (1947) subjected cinema records and supplementary stenographic protocols to analysis in studying the development of handedness of a small group of children from birth to 10 years of age, with special attention to the first year of life. Age level summaries indicated the gradual and consistent development of laterality. The conclusion reached was that handedness is a product of growth.

3. *Studies of Nursery School Age Children*

Handedness is fluctuating and unstable during the nursery years. However, all observers report increased preference for right-handedness during the ages of two to five.

Gesell observed handedness in children between 18 months and two years of age who were given crayon and paper for scribbling. The right hand was used exclusively for picking up and writing by 68 per cent of children at 18 months, by 92 per cent at two years; but handedness could not be predicted definitely until later. From three to seven years there was marked increase in the number of right-handed children and decrease in ambilaterality (16 cases). A higher relation was found between handedness and footedness than between handedness and eyedness.

Gesell's study of children 18 months to five years of age shows better bodily poise, faster, straighter reach, and more accurate grasp with the right hand than the left (1940). The increase in strength and skill was greater for the right than for the left hand.

Updegraff (1932) tested and observed the handedness traits of 40 nursery school children between the ages of two and six. The tests were repeated on two successive days. Five out of 40 or 12.5 per cent used the left hand more than the right (Table 1).

TABLE 1

Per cent of use of preferred hand	Number of children
91-100	11
81	8
71	9
61	8
51	4

The children proved to be much more variable in bimanual than in unimanual activities. There were no observable age differences in dominance. The left-handed children used the right hand more frequently than the right-handed used the left hand. The left-handed children did not show such conspicuous dominance as the right-handed. More right-dominance was shown during the tests than during the observations. More consistency was shown in taught or much practiced hand usages than in those little practiced or untaught. In this study the data were not broken down for different age levels. In a study of the ability of young children three to five years of age to trace a path, Wellman (1926) found that children showed improvement with the right hand but little improvement with the left. There were only slight differences between the skill of the two hands at the age of three.

H. E. Jones (1931) used some of the Merrill-Palmer tests in studying the manual performance of 60 children ranging in age from 18 months to 38.5 months, and computed the work ratios of the two hands. At 24 months the work ratio was approximately .66, at 36 months .70, 48 months .75, and at 54 months .80. On the basis of regression of dextrality on age he estimated a .59 ratio at six months, .56 at birth, but admits that this requires a forcing of the data. He raised the interesting question as to the age at which a .50 ratio would be expected. Dextrality ratios for girls tended to be higher than for boys and rate of increase with age was higher for girls. Jones also found a tendency for bimanuality to increase with age. In the youngest group the two hands were used together only 11 per cent of the time. In the oldest group this figure rose to 23 per cent.

Downey (1928) observed 49 nursery school children ranging in age from two years, nine months to five years, 10 months. The children showed less stable reactions than are found in adults. According to Downey, many handedness habits have become stabilized by four or five years of age, and there is little fluctuation after that time unless extreme instructional pressure is brought to bear.

There is a shortage of data for the separate age levels three to six due to the tendency of research workers to lump together data for children in this age range. Judging from trends before and after this period, during the ages three to six there is a reduction in about three or four per cent of left-handedness.

Two studies were made by Heinlein (1930) of nursery age and older children. In one study, 24 children ranging in age from two to six were given a battery of handedness tests. Heinlein reported finding degrees of preferential handedness rather than two distinct manual types, right and left, as conventionally designated. Two-thirds of the children showed more tendency to be right-handed, one-third to be left-handed or ambidextrous. In another study, with groups ranging in age from four to 12, of 60 children, 25 per cent showed consistent superiority of the right hand in tests of tapping, steadiness, and aiming at a target, whereas 71.7 per cent were indifferent in handedness on the different tests. Heinlein, as well as Downey and others, noted how much positional convenience influenced the preferential manipulations of preschool children.

4. A *Study of Nursery School Children*

In order to gather more information about nursery age children, the writer (1948) undertook a study the results of which tend to confirm the findings of other workers and to add considerable new data. The subjects were 44 nursery school children between the ages of two and four enrolled at the Manhattanville Day Nursery in New York City in 1946. Observations were limited to one-handed behavior since it is chiefly unimanual skills that present problems in child training. Although it was impossible to undertake a training program, the effects of incidental training and social conditioning were observed.

The questions proposed in the research were: When a young child uses one hand alone for any activity, which hand does he use? What is the relative proportion of right and left choices for various activities among these children in different age groups? What appear to be the effects of training? Are there differences between boys and girls in these traits?

There were 25 boys and 19 girls among the group of 44 children. The distribution of their ages is shown in Table 2. None of the children were mentally or physically handicapped in any way, but they showed typical variability in mental and emotional responsiveness, and attendance of a number of them was irregular because of illness or exposure to common childhood illnesses. As a group, they were normal in motor development and, as a result of their nursery school experiences, well above the average in self-help. Some of them showed less than average maturity in language development, possibly because of foreign background.

TABLE 2
AGE DISTRIBUTION FOR THE 44 NURSERY SCHOOL SUBJECTS

Age	
5-0	
4-9	2
4-6	2
4-3	8
4-0	7
3-9	5
3-6	3
3-3	4
3-0	5
2-9	2
2-6	2
2-3	2
2-0	2
Median	3-10
Total	44

Systematic observations were made of the hand employed in eating with spoon and fork, eating with the fingers, i.e., taking a piece of bread or slice of apple, and drinking from a glass or cup. Extensive observations were also made of the random "off-guard" behavior of these same children in the room and on the playground in such activities as throwing things, picking up and handling various tools and toys, taking hold of another child, pulling and pushing vehicles, shoveling and using utensils in the sand pile, bodily habits such as thumbsucking or scratching one's self, hitting and slapping. Repeated observations were made of each child for several days in succession until an adequate sampling of each child's behavior had been recorded. The records covered a five- or six-day period for every child. The two-year-olds did not use forks; consequently observations of eating with silverware in this group were confined to using a spoon. The random acts observed averaged 19 for each child in the two-year-old group, 14 for the three-year-olds, and 15 for the four-year-old group.

In addition to the observations, each child was tested several times on different days in throwing a ball, shaking a rattle, spinning a top, drawing with crayons, using a toy shovel, and running a toy automobile.

Handedness indices or ratios were computed for each child's results as a whole and for the three separate age levels for each test or observation category, using the formula employed in previous studies by Koch (1933) and Durost (1934). The formula is:

$$\text{Index of dominance} = \frac{R - L}{R + L}$$

in which R and L stand for right hand and left hand, respectively. This formula gives the per cent of predominance of right or left choices to the total number of choices. High scores approaching 1.00 signify completely consistent right-hand dominance, low negative scores approaching —1.00 indicate consistent left-handedness, and scores around .00 mean ambilaterality or lack of distinctive dominance.

Table 2 shows the age distribution for the children who were the subjects of this study, Table 3 gives the right- and left-hand indices for the three age groups in all the skills tested, and Table 4 gives a distribution of right- and left-hand indices for all skills combined for all of the subjects. The distribution of these indices is shown graphically in Figure 1.

The median index was .48 with the distribution skewed to the right. Six of the children or 11.1 per cent fell in the left-hand side of the distri-

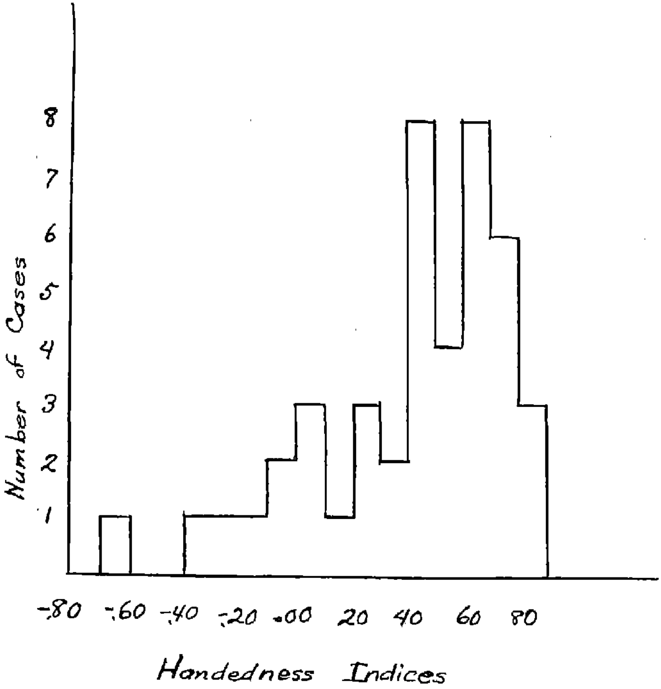

FIGURE 1
DISTRIBUTION OF HANDEDNESS INDICES FOR 44 NURSERY SCHOOL CHILDREN

bution curve. This is close to Updegraff's figure of 12.5 per cent left-handedness for nursery school children.

An examination of Table 3 which gives the indices for eating with fork and spoon, eating with the fingers, drinking from a glass or cup, the various test items and the random observations shows marked differences among these various items. The highest positive indices for all age groups are found for eating with a spoon, .834, .81, .676 for the three age levels, and using

TABLE 3
RIGHT AND LEFT-HAND INDICES FOR THE THREE AGE GROUPS

Activity	Age 2	Age 3	Age 4
Using spoon	.834	.81	.676
Using fork	——	.821	.575
Drinking—glass or cup	.212	.304	.387
Eating with fingers	.00	.147	.015
Throwing ball	.722	.774	.655
Spinning top	.304	.476	.50
Shaking rattle	.375	.60	.612
Using crayons	.631	.874	.60
Using shovel	.647	.705	.62
Running toy car	.52	.253	.151
Other activities	.0327	.353	.156

a fork, .821 in the three-year level. The lowest indices for the three groups are found in eating with the fingers, .00, .147, .015 for the three different age groups. Throwing a ball ranks next highest after eating with silverware, .722, .774, and .655; followed closely by using crayons, .631, .874, and .60. In fact, in the three-year group using crayons shows a higher index of right-handedness than throwing a ball. Using a shovel also shows relatively high indices for all age groups, .647, .705, and .62, suggesting a possible association between this activity and using a spoon or fork.

Indices for "other" activities representing the random observations in spontaneous acts are not far from the zero point or ambilateral line in all three age groups, for age two, .0327, age four, .151,—except for the three-year group where the index rises to .353.

Drinking from a glass or cup shows consistently higher indices for all age groups than "finger feeding," yet it is consistently nearer the zero of ambilateral line, .22, .304, .387, than to perfect right-handedness.

The differences among these various indices may not be statistically reliable because in each instance the number of cases is small. However, the trends are unmistakable and appear at all age levels.

The trend toward right-handedness increased in the three-year group as compared with the two-year group, .375 for the two-year-olds, and .625 for the three-year-olds, but it dropped again for the four-year-old group, .475. Left-handedness increased in the four-year group. Both ambilaterality for random acts and right-handedness in eating were highest in the two-year group. This fact would seem inconsistent except that ambilaterality in this group reflects the lack of maturity in motor habits characteristic of the two-year-old, and the high index of right-handedness in eating suggests the ease with which two-year-olds respond to motor training whether it is

TABLE 4
DISTRIBUTION OF RIGHT- LEFT-HAND INDICES FOR THE 44 SUBJECTS

	Age 2			Age 3			Age 4			
Index	Girls	Boys	Total	Girls	Boys	Total	Girls	Boys	Total	Total
.80					1	1		1	1	3
.75				1		1	1		1	2
.70				2	1	3		1	1	4
.65				1	1	2		1	1	3
.60	1		1	1	2	3	1		1	5
.55				1		1	1		1	2
.50							1	1	2	2
.45		1	1					3	3	4
.40	1	1	2		1	1		1	1	4
.35					1	1		1	1	1
.30	1		1							1
.25		1	1	1		1	1		1	3
.20										
.15					1	1				1
.10										
.05										
.00		1	1	1		1	1		1	3
—.05	1		1				1		1	2
—.10										
—.15								1	1	1
—.20										
—.25								1	1	1
—.30										
—.35								1	1	1
—.40										
—.45										
—.50										
—.55										
—.60										
—.65										
—.70					1	1				1
N =	4	4	8	8	9	17	7	12	19	44
Median =	.375	.35	.375	.65	.625	.625	.525	.4667	.475	.487
Range =	—.042 to .603			—.674 to .81			—.32 to .834			

Median index for the left-dominant = —.175
Median index for the right-dominant = .55

direct or incidental. These are not reports of the same children carried through a three-year period, but different groups at the three age levels.

The four-year group differed from the other two in two important respects: there were more boys, proportionately, in the group and fewer of the four-year-olds had entered the nursery at so young an age as the two- and three-year-olds. Hence, any training factors were weightier for the first two groups. More of the four-year-olds brought with them hand usage habits already established at home, especially for eating.

Among these nursery school children left-handedness proved to be not only much less frequent than right-handedness, but less consistent or dominant. Only one of the 44 children was a consistent left-hander. The median index for the six "lefties" was —.175. In the two-year group any child with strong dominance was right-handed. The only consistently left-handed child in all the groups was a member of the three-year group who was new to the school at the time the observations began. On the first day his mother called attention to the fact that he was a left-hander and requested the teacher to permit him to use his left hand in eating. In all three age groups left-handedness was more common among boys than girls.

The left-handed group as a whole proved to be younger children for the most part who were new to the school or older on entrance than the typical child in the nursery. Two-thirds of the left-handed group were boys. Three of the five negro children in the nursery population fell into the left-handed group. The six left-handers had a median age of 4-2, whereas the average for the nursery group without these six was 3-9. These left-handed children proved to be more strongly left-handed in eating than in any other trait.

Only one child in the group stuttered persistently. He was a four-year-old negro child new to the school when the observations began. This boy's index was negative, —.214, indicating left-handedness, but others with similar degrees of left-handedness did not stutter. An analysis of the stuttering boy's indices for various acts shows that all indices are highly consistent for left-handed eating but that in other activities his indices were near the ambidextrous line. The other children whose average indices were similar to his were less left-dominant in eating, more consistently near the ambidextrous line in all hand usages.

Observations revealed that the nursery school teachers directly or indirectly influenced the children toward left-handedness even though they were committed to a policy of "hands off" in matters of hand training. These training influences were most obvious in the children's use of silverware. The new children showed readiness to "fall in line" with the hand usage in eating that they observed about them.

Several lines of evidence from these data favor an explanation of these children's handedness tendencies largely in terms of training:

1. The differences in the indices between eating with implements and eating with the fingers. (The latter skill is untrained.)
2. The differences in the indices between eating habits and other acts requiring similar dexterity, especially in the two-year group.
3. The differences in degree of dominance between those who had re-

mained for a longer period of time compared with those who had been in the nursery school for a shorter period of time.

4. Differences between boys and girls which appear to have a social basis.
5. The lack of left-handed cases in the two-year level corresponding to right-handed cases in the same group and the later appearance of left-handedness among young children.

5. *The Handedness of Two-Year-Olds*

Among eight two-year-olds in the nursery school study reported above none were left-handed judging from the handedness ratios computed for each child. Additional observations were made of two-year-olds in an outdoor play group. Handedness was checked while the children were busy shoveling sand, dumping sand and water, throwing and hitting, picking up objects, spooning water, using sticks, string and blocks, and making mud pies. The results were as follows:

1. Two-year-olds showed more ambilaterality and inconsistency in hand usage than older children.
2. Some children of this age were already decidedly right-handed.
3. There were no children who were consistently left-handed.
4. Even at this age the girls showed more right-handedness than the boys.

In all studies of children's handedness reported by "scientific" parents there are no cases of consistent left-handedness in two-year-old children. The children are either right-handed or ambilateral. (See reports in the following section.) Apparently there is no such thing as a consistent left-hander among two-year-olds who are physically normal. The conclusion is borne out in the cases reported by Gesell and Ames (1947). These facts lend support to the view that consistent hand dominance is a matter of habit formation produced by training and experience.

Catherine, aged 2 years, 5 months, is a typical ambilateral two-year-old. Her mother on seeing her use the left hand frequently in ironing doll clothes, turning book pages, drinking from a cup and scribbling concluded that she must be a native left-hander, and encouraged the child to use the left hand because she had heard of the disastrous consequences of interfering with this trait. Doubts concerning the child's "native" left-handedness expressed by other members of the family prompted the mother to take the child to a specialist for examination. The activities tested included observations of finger pointing in looking at pictures, turning book pages, scribbling, taking and using pencil, unscrewing bottle cap, throwing paper wad, tearing paper, drinking from cup, eating with spoon, pushing a board, spreading out a handkerchief, using toy iron, using key, opening door, turning a doorknob, eating crackers, sucking thumb. The child's score on 37 different acts was: Right, 19; left, 18; handedness index, .027. These results indicate that the child is ambilateral rather than left-handed and at this early stage could easily be trained to right-handedness. Social conditioning first begins seriously when the child drinks from a cup alone and attempts to feed himself with a spoon. This conditioning continues as he begins to use a crayon or pencil; he may practice for a considerable time before he is corrected. Social pressure to conform increases in intensity with age.

There is a need for new studies that will give us a better understanding of the development of handedness in early childhood in relation to other manifestations of motor activity, eye control and eye-hand dominance, sidedness in general, speech and locomotion.

6. *Individual Studies*

Individual studies of children during infancy and early childhood made by "scientific" parents contribute additional material that throws light on the development of hand dominance during the first few years of life. Voelckel reported on all the individual studies that had been published before 1913. One of the first investigators to report on an individual child was J. M. Baldwin (1890). His experiments on his own child extended throughout the child's first year. The test used was reacting to colors. Results were as follows:

1. There was no trace of either right- or left-handedness so long as no violent muscular exertions were made.
2. During the sixth to tenth month the child showed a tendency to use both hands together twice as frequently as each separately.
3. Distinct preference for the right was shown in violent efforts at reaching in the seventh and eighth months.
4. Up to this time the child had not learned to walk nor creep; hence, preference could not be attributed to difference in weight of the body on the two different sides.
5. By the seventh month the child's visual estimation of distance was exact enough to reach for an object more than 14 inches away.
6. By the 13th month the child was a confirmed right-hander.

Baldwin (1895) noted that gestures with the favored hand were used for expression long before the beginning of speech. Concomitant mental and physical development was characteristic of his child's growth.

William James (1890) commented that Baldwin believed the right hand began to be used in favor of the left only when the movement required an effort. It was James' opinion that memory of previous superior effectiveness of the right hand determined its subsequent use.

Professor Valentine's boy at age seven months was more left- than right-handed in color grasping tests, but gradually he became right-handed.

D. H. Major's observations of his child's handedness began in the third month after birth (1905). The record is as follows:

> 3rd month—no preference for either hand was noticeable.
>
> 4th and 5th months—the right hand was used more frequently.
>
> 6th to 11th month—no noticeable preference for either hand.
>
> 12th month—a slight preference for the left hand began to appear early in the 12th month and by the end of his first year the child appeared to be left-handed. He used the left hand for picking up toys, throwing a ball, and tossing a ball. The left hand was used more in reaching. Left-handed movements were surer and more numerous.

At this point the parents began to break up the growing preference and to encourage the child to use his right hand rather than the left. Articles were refused him when he reached with the left and care was taken to place toys and other articles in his right hand. Toward the latter part of the 15th month the right hand began to return to its former ascendency. In the last week of the 15th month during one observation period there were 24 reaches with the right hand, 21 with the left, and 4 with both hands.

From the 16th month there was more use of the right hand than the left and by the 20th month ball throwing and spoon holding were decidedly right-handed. By this time the habit of throwing with the right hand was thoroughly fixed. When the ball was picked up with the left it was changed to the right before being thrown. By the end of the second year the child was decidedly right-handed and remained so beyond his 44th month. Due to this experience with his child the father questioned whether handedness was not primarily a matter of training.

Dearborn (1910) reported observations of his child's handedness from birth until the third birthday. By five months of age a trend toward right-handedness was observed, and by 14 months the right hand was used predominately. Mrs. Fenton's child (1925) showed little hand preference in the early grasping movements, and when it did appear the preference shifted several times before settling in one hand. Right-handedness was observed in her child by the 30th week and persisted from then on, although in the 11th and 12th months left- and right-handedness were nearly equal.

Both the ape and the infant observed by Kellog (1933) showed comparable tendencies in handedness. At the age of nine months they reached more often with the left hand than with the right. In a few weeks the preference had shifted to the right hand, and remained there until the age of 12 months, when it shifted again to the left, showing instability during this period. Kellog believed that training to eat with the spoon in the right hand was the reason for the right-handed preference after nine months. For the total nine months' observation period the record for the ape was: left hand 107, right hand 110, both 2. For the child: left hand 37, right hand 36, both 13. The child used both hands coördinately earlier and more frequently than the ape.

Mrs. Woolley (1910) made a study of her child's handedness, using colored discs placed side by side before the child and a test requiring reaching varying distances. The child was seven to eight months old at the time of the tests. In the color discs test, the child used her right hand 206 times, the left 195 times and both hands, 68 times. Mrs. Woolley concluded that this was not enough difference to be of any significance. In the first week of the study the child used her left hand even more frequently than the right. In the reaching tests the child showed preference for the right hand. This finding is the same as that reported by Baldwin with respect to handedness for energetic reaching. During observations at other times than the actual testing, Mrs. Woolley did not observe any difference in the child's hand usage in the seventh or eighth months. In one game the child played with a ball and string using both hands. The hands were used indifferently in both ball activities. During the middle of her eighth month she began to wave "Bye-Bye" with her left hand, later with both hands, but right-handed waving gradually gained the ascendency until by the time the child was 15 months old she invariably used the right hand for waving. Toward the end of the eighth month single hand play with a ball favored the right hand, with the left being used occasionally. During the ninth month the right hand was more frequently chosen for ordinary activities, and by the end of the ninth month the predominance of right-handedness was obvious on even casual observation. By the 17th and 18th months the spoon and pencil were invariably held in the right hand and the child proved to be clumsy with the left. Mrs. Woolley asserted that no direct training was given to encourage right-handedness, and that the position in which the nurse held the child favored left-sidedness.

Twins whose behavior was observed and filmed from birth to the age of two years eight months, by H. D. Behrens had both developed right-handedness by the end of that period. Dr. Behrens reported that when one of the twins was placed in a different position and the parents were advised to place the child in the different position, he quickly developed into a right-handed individual and has remained so ever since.

The nursery children studies by Gesell and Ames (1947) bear out the rule that children who are placed under close scientific observation turn out to be right-handed. Of their seven cases six became right-handed and one remained ambilateral. None became left-handed.

From all these different studies of young children several conclusions are evident:

1. There is considerable variability in the degree of hight-hand dominance depending upon the particular skill observed. There is more consistent right-handedness in taught than in untaught skills or those that are socially influenced.
2. Nursery-age children attempt to eat and scribble with the left hand because they are immature, not necessarily because they are "born left-handers."
3. It appears to be fairly easy to control hand preference in young children through training in the use of eating implements and in the way things are handed to them.
4. Positional convenience has much to do with hand preference for unpracticed acts.
5. During the nursery years, left-handedness is a much less consistent trait than right-handedness.
6. In all the individual studies of handedness in young children reported by scientific parents and professional observers the children became right-handed. Yet in the general population of children two to four years of age there is 10 to 20 per cent left-handedness.

B. Incidence of Right- and Left-Handedness

1. *The Incidence of Left-Handedness*

Right-handedness predominates among cultured people around the world today just as it did in ancient times. How common is left-handedness? There is no simple answer to this question. The proportion of left-handers varies with the age levels of the subjects, their mental ability, the nature of the capacities tested, the frequency and types of observations made, and the cultural background of the population studied. Figures based on small numbers of cases or limited observations, as well as those that fail to report the subject's ages or throw together data from different age groups tend to be unreliable.

Selzer (1933) summarized results of a questionnaire sent to large cities of the country asking for the percentages of left-handedness, methods of testing, and attitude of teachers and supervisors toward left-handedness. Reports varied from one or two per cent to as high as 16 per cent, depending on the criteria used and the particular group observed. Wile (1934), in summarizing the data from the principal research studies, gives a table in which the incidence of left-handedness is shown to range all the way from one to 30 per cent, the variations being due to the nature of the population studied and the methods of investigation that were used. The figure most often given: 4, 4.5, or 5 per cent holds good only for the older members in the population and for skills that are directly taught, such as eating and writing. Burt finds that on the basis of a writing test alone the percentage of handedness is very small and dwindles rapidly with age.

About 7 per cent of younger school children on the average show strong left-handed tendencies. These children prefer to write with the left hand and to use the left hand in eating, throwing, cutting, and other activities that call for manual dexterity.

It is estimated that there are some seven million left-handed persons in the United States, and that 250,000 left-handed six-year-olds enter the first grade every year. Usually there are one to four "lefties" in a classroom, sometimes six or more. Many others who have been "converted" before school age show vestiges of left-handedness.

2. *Increased Incidence Within Recent Years*

It was noted in Section II that left-handedness appears to have increased in recent years due to relaxed home and school attitudes in training children. Burt (1937) reports the following per cents for left-handed writing with pen and pencil:

1913	3.8% boys	2.1% girls
1923	4.9% boys	2.7% girls

In a New York suburban community there has been an increase in the number of left-hand children who write with the right hand within a decade. In 1932, 2.2 per cent of the children enrolled below high school level were left-handed writers; in 1937, 4.06 per cent; in 1941, 6.2 per cent.

A survey of 365 schools in Michigan made since 1945 showed that 8.2 per cent of 225,000 pupils were left-handed. The conclusion was drawn that environmental left-handedness is relatively greater than it was a generation ago and that it is still increasing (Carrothers, 1947).

3. *Comparative Incidence in Different Functions*

The incidence of left-handedness is in part a function of the capacities tested. In some motor skills the same individuals are more strongly left-handed than in others. Performance may be uneven from test to test. Durost's data (1934) showed that left-handedness as well as right-handedness becomes more pronounced as the tests involve finer coördinations.

Haefner (1929), who tested two groups of school children, 68 in each group, half left-handed and half right, ranging in age from nine to 12, gives the following numbers and percentages of left-handed and right-handed groups who performed each handedness test with the *dominant* hand (Table 5). He found that using both hands in coöperation tended to reduce the dominance of the preferred hand.

TABLE 5

Test	Left-handed group		Right-handed group	
	No.	Per cent	No.	Per cent
Direction of movement	18	26.5	53	77.9
Throwing	63	92.7	61	89.7
Receiving	49	72.1	47	69.1
Easy reaching	56	82.4	54	79.4
Energetic reaching	51	75.0	55	80.9
Thumb up	44	64.7	36	52.9
Batting	41	60.3	47	69.1
Sweeping	20	29.4	24	35.3

Johnson O'Connor of the Human Engineering Laboratory, New York, listed 15 activities more or less susceptible to training and tested all the clients, chiefly adults, for left-sidedness in these traits (Table 6).

The differences in per cents can be explained in terms of social prestige of the functions performed.

TABLE 6

Shaking hands	0.0%
Cutting meat	3.3
Batting baseball	3.3
Golf stroke	5.0
Writing	6.0
Combing hair	6.7
Buttering bread	6.7
Hammering	6.7
Ping pong stroke	6.7
Kicking football	6.7
Tennis stroke	8.3
Throwing baseball	8.3
Aiming rifle	13.3
Dealing cards	15.0
Sighting	25.0

TABLE 7

PERCENTAGES OF LEFT-HANDEDNESS FOUND IN VARIOUS POPULATIONS

Authority	Place	Date	Age of subjects	All	Male	Female	No. of cases
Schaefer	Berlin	1910-11	School Children	4.06	5.15	2.98	17,074
W. F. Jones	England	1915	School Children	4.43			
Ballard	England	1911-12	School Children	4.3			13,189
Ballard	England		School Children	2.7	3.5	1.8	322
L. Smith	U. S. A.	1917	School Children	4.5	4.5	4.5	2,055
Gordon	England	1920	Children (Ages 4-14)	7.3			3,298
Burt	London		School Children	4.8	5.8	3.7	5,000
Burt	England		School Children	5.2			600
Wilson and Dolan	U. S. A.		School Children (Handwriting)		4.62	2.62	
Barbeleben			School Children	6.8			
Haefner	U. S. A.	1929	Children (Avg. age 11)	6.3	6.7	6.0	1,144
Selzer	U. S. A.	1933	School Children	5.8	7.1	4.4	
Daniels	U. S. A.	1940	College Freshmen	2.13			1,594

Of the children in the Cambridge schools studied by Selzer (1933), more than 13 per cent of the girls tested left-handed by the throwing test, 4 per cent by the writing test. Observations of handclasping show that in 50 per cent of the cases the right thumb is uppermost, in 50 per cent the left.

4. *Data for Various Populations*

The proportion of dominant handedness in the population can be described in two ways: in terms of the per cent of proportionate use of the two hands in a series of individuals; and second, the percentage of individuals in the population who tend to be right-handed and those who are left-handed.

The incidence of left-hand individuals reported for various populations is shown in Table 7. There is a noticeable increase in right-handedness with maturity. Including younger children in the survey always tends to increase the proportion of left-handers.

Data obtained by W. F. Jones (Table 8) for a peg board test show the index of left- to right-handedness in both right and left handed subjects. The index computed was $\frac{L}{R}$. Here again the increase in right-handedness with age is evident.

TABLE 8

Age group	Right-handed subjects	Left-handed subjects
8	.778	1.259
10	.811	1.159
12	.888	1.128
15	.895	1.052
18	.933	1.38

5. *Incidence of Handedness in School Children and Student Groups*

In testing 600 school children, Burt (1937) found just 5.2 per cent to be left-handed. Of these only four out of five among the boys and only three out of five among the girls used the left hand for writing or drawing in the classroom. Other data for school children are given in Table 7.

Chamberlain (1928) found 4.3 per cent of American College freshmen to be left-handed. Other studies corroborate the findings that college students show the lowest percentage of left-handedness of all populations.

6. *Distribution Curves for Handedness*

When the data from handedness tests are transmuted into indices of handedness by a formula such as $\frac{R - L}{R + L}$, which gives the percentage of right- and left-handed preferences, a frequency curve for right- and left-handedness can be constructed. That is the technique Durost (1934), Koch (1933), Ojemann (1930), Burt (1937), and others have used or recommended.

Burt noted that the curve for handedness is continuous but not symmetrical. The right-handed group is far larger than the left, and the groups overlap. The left-handed group varies far more widely than the right-handed group. The double peak in the curve is less evident in the younger than in the older groups.

Koch (1933) found a clear-cut bi-modality with the most reliable tests of the series used. Six per cent of the cases fell in the lower or left mode of the distribution. Koch remarked that we should be interested in dispersion of the trait as well as skewness or modes. Bimodality may be created artificially in the distribution by selecting activities in which the performance of right and left hand differ markedly.

Durost (1934) found the distributions to be decidedly more peaked than a normal curve (see Figure 2). The obtained distributions might be regarded as two separate distributions merged into one. Ojemann (1930) shows a distribution curve for handedness in five tests combined.

All data show the gradual decline in left-handedness with age. This proves it is not a fixed character that remains constant with age.

Figure 3 is a smoothed curve based on massed data showing the increase in right-handedness with age. It represents a growth or learning curve for right-handedness comparable to learning curves for other mental functions.

7. *Sex Ratios in Handedness*

Most authorities find left-handedness far more common in boys than in girls, and adult men compared with women. Brain (1945) reports the trait to be twice as common in males as in females. It is rather unusual to find girls in the upper grades and high school who have not well-established manual dominance, and among them left-handers are comparatively rare; whereas left-handed boys and boys with confused handedness are more common. A clear-cut difference in sex ratios is shown by beginning school age.

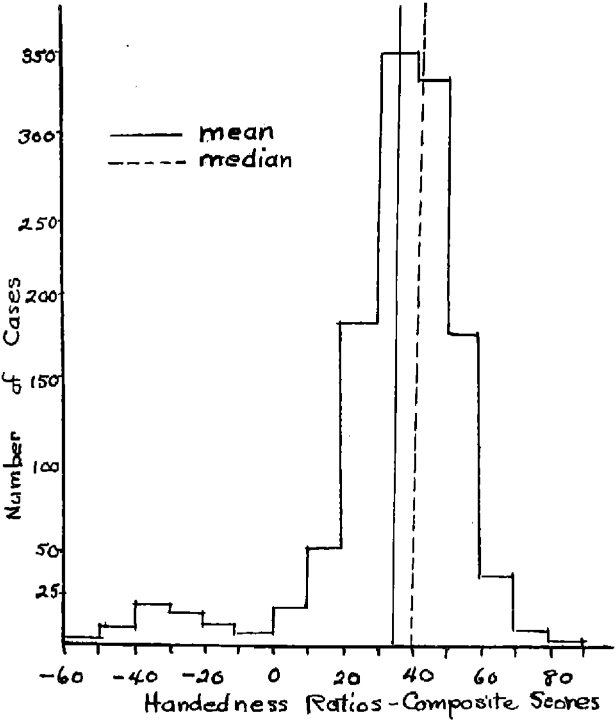

FIGURE 2
DISTRIBUTION OF HANDEDNESS RATIOS—COMPOSITE SCORES FOR SCHOOL CHILDREN (DUROST, 1934): POSITIVE SCORES INDICATE RIGHT-HANDEDNESS, NEGATIVE SCORES, LEFT-HANDEDNESS

An examination of the data in Table 7 shows the extent of difference in various age levels.

Burt noted that left-handedness in infant schools was almost twice as common among boys as girls. This sex difference later tended to disappear. Boys outgrow the tendency more readily than girls or else teachers and

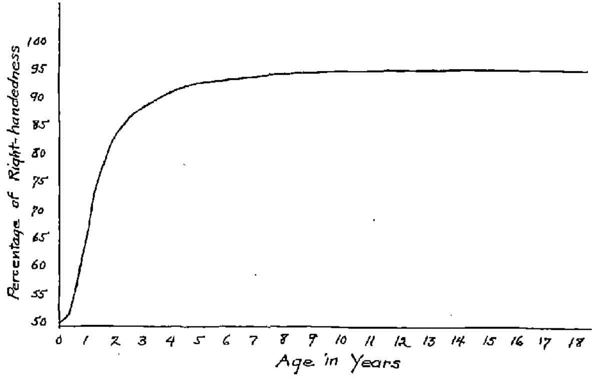

FIGURE 3
CURVE SHOWING THE INCREASE IN RIGHT-HANDEDNESS WITH AGE (MASSED DATA)

parents appear to be less insistent that girls outgrow the habit than boys.

Men and boys show more left-handedness than girls and women not because of any greater perversity or special deficiency but because they are more active in sports and outdoor activities of all kinds, chopping, operating vehicles, handling animals and fighting, with the result that they tend to develop both sides more uniformly. Girls and women learn delicate motor skills earlier such as sewing and writing, they do more table work, and they also conform better to social conventions, traits that favor the development of right-sidedness. The explanation has also been offered that boys are more self-willed than girls, whereas girls accept directional controls and instruction better.

8. *Converted Sinistrals*

The tendency of parents and teachers to "change over" the left-handed child accounts for some of the drop in the percentage of left-handed cases through the age range.

Haefner (1929) obtained information about *change* of handedness for 41 cases. Two children had been trained at home to use the right hand, 15 had been changed after they entered school, five had no recollection of the time and circumstances under which they had been retrained. Most of the children who were changed in school were changed in the first grade, but change was made also in every grade from first to fourth. Haefner found that 63 per cent of the total left-handed group had been "changed" for some skills, 69 per cent of the boys and 58 per cent of the girls. Selzer concluded that during childhood nearly half the population are changed from left-handed beginnings to right-handedness by social pressures.

Burt (1937) reported on "change over" for normal children with average intelligence as follows: (*a*) trained to use left hand, 4.2 per cent; changed to right-hand writing, 6.1 per cent. (*b*) Dull and retarded intelligence: trained to use the left hand, 6.2 per cent; changed to right-hand writing, 13.9 per cent.

Many left-handed children have been required to write with the right hand from the beginning. The few who have not are sometimes required to relearn writing with the right hand later.

Jones (1918) noted that out of 417 "born" left-handers, 323 were shifted to the right hand, four by accident and the rest by direct training.

Durost noted that a surprising element in the distribution curves was the slow rate of rise for the left-handed group, evidence of the degree to which left-handed people succumb to environmental pressure to use the right hand.

Who are the remaining uncorrected lefties? Apparently children who strongly resisted training given by their parents, individuals who were trained to be left-handed for any reason, those who imitated left-handed persons, those who have some disability in the right hand and arm or those who were left alone and through a combination of chance circumstances developed strong left-handedness. For a fuller discussion of this topic see Section III.

9. *Left-Handedness and Mental Retardation*

Everyone knows highly intelligent and mentally gifted people who are left-handed, so that in no sense can left-handedness be considered an unvarying sign of mental retardation. A small proportion of outstanding individuals in the population might be expected to retain left-handedness in the face of considerable opposition simply because they are intelligent and strongminded. Why, then, is left-handedness so commonly considered a sign of mental retardation? The answer is that the proportion of left-handers among the mentally retarded is actually larger than the percentage among mentally normal individuals, according to all authentic and reliable reports.

Left-handed persons are not duller in general than the right-handed, but left-handedness is found more frequently among the dull when that section of the population is studied. There are nearly twice as many left-handed among the mentally backward and three times that number among the mentally defective. The dull and mentally retarded appear to be doubly sinistral, never establishing a dominant lead in either hand.

A gradation is found between the merely dull and the seriously retarded cases in the degree of left-handedness shown. Furthermore, differences are found in incidence of left-handedness among the dull just as in normal populations, depending upon the types of tests used and the thoroughness of the survey.

According to Burt, the superiority of the right hand tends to be far less marked in the mentally defective than among the dull and in the dull than among the normal and bright. Selzer (1933) found unidexterity to be more pronounced in the normal or bright than in dull children; the bright were mere unidextrous than the average, and the average more than the dull or mentally retarded.

Gesell (1925) found slowness in mental integration shown in test responses to be associated with delay in developing unilateral dominance.

Wile (1934) discovered that dull left-handers were less likely to change their writing hand and tended to become ambilaterals. He found overt left-handedness to be more common among mental defectives (Table 9).

TABLE 9

IQ	*IQ*	*IQ*
50-89	90-109	110-
	Right-Handers (72)	
40%	42%	18%
	Left-Handers (36)	
28%	56%	16%
	Ambidexters (78)	
42%	50%	18%

Ballard found 6.5 per cent of children in special schools for the retarded to be left-handed: among normals, 4.3 per cent. Gordon (1920) examined 4,620 children in schools for the mentally defective, where he found 18.7 per cent to be left-handed, of whom 16.6 per cent were boys, 20.7 per cent girls; whereas the incidence among normal children of comparable age was found to be 7.3. In one class of mental defectives 37 per cent or nine out of 24 were writing or doing most of their school work with the left hand.

Data are given by Burt for the left-handed (Table 10).

In a questionnaire survey, Smith (1917) found 11 per cent of mentally

TABLE 10

	Backward	Defective
Boys	9.6%	13.5%
Girls	6.0%	10.3%
Average	7.8%	11.9%

retarded boys and girls to be left-handed contrasted with 4.5 per cent for normals.

In special classes Wilson and Dolan (1931) found the per cent of the dull left-handed children to be 6.37; in regular classes, 3.54. They found that the intelligence and mean achievement of dextrads was slightly superior to that of sinistrals.

Wisely (1930) found among 18,000 children only 6 per cent of right-handers who were grade repeaters, but 11 per cent left-handed and 15.8 per cent who had been converted from left to right.

Durost (1934) reported the mean school grade and conduct grade slightly higher for the right-handed group, but the differences found were not statistically reliable. However, the data showed that the direction of difference was consistently in favor of the right-handed.

Observations made by Mintz (1947) of 97 mentally sub-normal boys ages 7 to 17 with *IQ*'s ranging from 47-87 showed that about 75 per cent were right-handed, the remainder left-handed.

The best explanation of the greater incidence of left-handedness among the dull and mentally retarded is that they are less responsive to social training, they receive less of it, and they do not learn so easily from incidental clues. Brighter children respond more quickly to the natural training of their environment.

10. *Handedness of the Deaf and Blind*

Occasional studies have been made of handedness tendencies among the physically handicapped. In a brief survey Smith (1917) found 11 per cent of blind girls and 10 per cent of blind boys to be left-handed; among the deaf, 3 per cent of the girls and 4 per cent of the boys. Ballard found among the congenitally blind the same proportions of right- and left-handedness as among the normal seeing children. The results vary depending upon whether the worker is studying a mentally normal or a mentally defective population. The scant evidence on this point and its significance for understanding handedness problems suggests that more carefully controlled studies of handedness in physically handicapped children should be made.

11. *Handedness in Primitive Tribes*

In a report of handedness tendencies among Navaho Indians, Bullen (1945) reported that half of the boys tested right-handed, the other half mixed dominant, a much larger proportion of mixed dominance and smaller proportion of right handedness than is found in the normal white population of North America. Similar results have been reported for other primitive tribes around the globe.

12. *Handedness Among Twins*

Twins are said to show prevalence of sinistrality far beyond the normal expectancy, but sweeping generalizations have been drawn from scanty data. Here again the incidence found varies with the age of 'the twins studied and the techniques used in the investigation. Gesell (1931) and others have reported chiefly on *infant* twins who would tend to show the larger incidence of left-handedness and ambilaterality found in infants generally.

The data from twins are often cited as evidence of heredity in handedness. Gesell commented that the frequency of left-handedness in twins suggests an "epigenetic factor of a regulatory nature"; but the data suggest that twins, like other children, succumb in childhood to pressure for conversion from from left to right and that if heredity is operative it is too weak a factor to stem the tide of social pressure.

Data from 10 different studies were reported by Gesell. In Newman's study of 50 twin pairs, 25 pairs were both right-handed, 11 were both left-handed, 12 pairs showed one member left- and one right-handed, and in two cases both members were ambidextrous.

Of 253 pairs of young identical twins studied by Gesell, 11 pairs were both left-handed; in 56 pairs, one was right-handed, the other left-handed; in 56 pairs, one was right-handed, the other left-handed. Eleven pairs had one or both twins partly left-handed, and two pairs had both members ambidextrous. At least 25 per cent manifested sinistrality. This figure is about the same as that for non-twin infants below two years of age.

Gordon (1920) studied the handedness of school-age twins (Table 11).

TABLE 11

Sex	No. of pairs	Both *RH*	Both *LH*	One *L*, One *R*
Boys	59	47	0	12
Girls	79	69	1	9
Boy and girl	81	53	3	25 (11 boy *R*, girl *L*) (14 girl *R*, boy *L*)

Wilson and Jones (1932) collected data on handedness of 386 twins ranging in age from 10 to 20 and compared the incidence of handedness among the twins and a large number of non-twins of similar age. For throwing, the incidence of left-handedness was higher among the twins than the "controls," but for writing and other manual traits no reliable difference was found. Unfortunately the controls were not perfect matches in age or sex distribution. A good bibliography of research studies on the question is contained in this publication.

Brain (1945) cites twin data reported by Dahlberg of Stockholm (1926) for 124 pairs of children. Of these pairs six were both left-handed, 89 were both right-handed, 29 had one right- and one left-handed member.

Wile suggested determining whether twins with opposite or mirrored hair whorls have opposite handedness. He believed that studies of this sort would be a valuable contribution to research. The facts are needed for twins at all age levels because of the tendency of left-handedness to decrease with age.

13. *Other Aspects of Laterality*

Few data are available for other aspects of sidedness except eyedness. This topic is considered in Section V. Downey found that only a small proportion of children showed any tendency toward dominant footedness. Kellog (1933) reported that the ape he observed showed footedness corresponding to handedness which shifted back and forth from month to month.

14. *Ambidexterity*

Ambidexterity (or ambilaterality) refers to impartial preference in the use of the hands and implies equal skill in both. Actually, there is no such thing as true ambidexterity in man. Infants, the great apes, and other animals such as squirrels are referred to as ambidextrous, but none of these are ambidextrous in the sense of having any highly developed skill in both hands or forelimbs. It would be more accurate to call this two-handed or neutral condition ambilaterality. Persons with this condition are left-handers who have gained some skill with the right hand, right-handers who have cultivated some degree of left-handedness or individuals who have never achieved any manual dominance. Sportsmen, house painters, laborers and outdoor workers come nearest to fitting this description. Right-handed individuals sometimes show ambilaterality in the period preceding sleep. The truly ambidextrous individual is one who could interchange all skills with either hand leading, and the skill with both hands would be equal.

A recent newspaper article described an Australian artist who is expert in painting with both hands at once. As she paints, each hand appears to work independently and she gives the impression of being two persons at work at the same time. She can write normally with one hand and backwards or upside down with the other. A house painter who works at high speed says he is ambidextrous.

Occasionally we hear of a surgeon who can perform delicate operations equally well with either hand, or of a waiter who can carve a fowl using either hand with equal dexterity; but even in such rare cases true equality of the hands for skilled acts is difficult to demonstrate. The ambidextrous person usually prefers to use one hand for some purposes, the other for different skills. One hand is preferred consistently for the more accurate or delicate manipulations.

There are some skills such as the surgeon's use of his instruments in operations that benefit from dextrous and interchangeable use of both hands, or equal power and strength in both hands. In typing, playing the piano or harp, horse-back riding, carving, dressing, dusting or scrubbing, it is an advantage to have a high degree of strength and skill in both hands. Champions in physical skills are sometimes discovered to be persons who showed left-handed tendencies early and kept up skill in both hands as they felt the pressure to become right-handed.

Right-hand laborers are observed to perform as much as 30 per cent of their work with the left hand, but this does not mean highly skilled work with tools and suggests a division of labor between the two hands rather than true ambidexterity.

Wile, Burt and others note that what is usually termed ambidexterity is really converted sinistrality. Adults who claim to be ambidextrous are left-handed persons who perform some skills with the right hand. We seldom hear of an ambidextrous person who was originally right-handed unless some accident temporarily incapacitated the use of his right hand. The left-hander tries to adopt right-handedness to meet social pressure to "change over" and in so doing he is forced to develop more even-sidedness.

In most cases what is called ambidexterity proves to be non-dexterity or double left-handedness. It is frequently found in children who have been partially changed over. These cases appear to have two left hands, or two minor arms instead of one in the major rôle. They are clumsy and unable to carry out any complex movements. Such cases are more frequent among the dull and mentally retarded than among those of normal intelligence. Sometimes the individual changes only for writing or eating, retaining most of his left-handed tendencies. Most people who claim to be ambidextrous in writing were originally left-handed writers.

The individual who considers himself to be ambidextrous has become habituated to doing some things with the left hand predominating, other things with the right.

A college student who says she is ambidextrous reports that she writes with the left hand but eats and does certain other things with the right. No one ever required her to write with the right hand, but she recalls that the writing period at school was a horror and torture. The teacher, using a formal method, tried to force her to hold her paper in the same slantwise direction as that of the right-handed children.

Mr. F. considers himself to be a rare case of ambidexterity. He reports that he was originally left-handed in everything but writing. In early childhood his left hand was sewed up in a bag to keep him from writing left-handed. When he went to work in a railroad shop at the age of 17, he used tools in the left hand, but he was required to shift to the right. He says a boiler maker must be able to use both hands equally well.

One ambidexter stubbornly insisted that he was equal handed, but within a half hour he was observed to use his right hand to take his hat from a hook, open a door, use a key, scratch his head, eat soup, and light a cigarette.

Occasionally right-handed children become pseudo-ambidextrous through imitating left-handed parents, nurses, other children or their teachers, but such imitation does not extend far beyond the skills of writing, eating, and and throwing. The left-hander who tends toward ambidexterity shows preference for the left hand in operations requiring unusual dexterity or force. Ballard (1911) observed that children alleged to be ambidextrous always showed a preference for one particular hand in learning a new act of skill.

15. *Incidence of Ambidexterity*

Burt (1937) found ambidexterity to be very rare among school children, and Schaefer (1911) reported only .021 per cent of 17,074 school children as showing ambidextrous characteristics. However, in the Syracuse University study made by Daniels (1940), 8.7 per cent of the students examined were found to be ambidextrous. The distribution curves in Figures 3, 4, and 5 show that ambidexterity occurs more rarely than left-handedness.

16. *Animal Handedness*

The lower animals cannot be said to exhibit handedness in the same sense or to the same degree as man, in the first place because their body structure and the necessity of being down on "all fours" most of the time precludes the opportunity of developing specialized usage of the fore limbs; and in the second place, because animals lack the mental organization for developing a high degree of specialization in the use of tools; furthermore they are not ordinarily subject to social pressures to use one member more than another.

Data from studies of handedness in domesticated and laboratory animals such as dogs, cats, and rats are conflicting. Left-handed tendencies are reported about as frequently as right. Birds, cats, and horses are all said to show sidedness in their movements. No doubt cats and dogs learn to be right-handed through training from their right-handed masters, but they do not develop the characteristic complementary use of the fore limbs shown by man with one subordinate to the other.

Observations indicate that although laboratory animals such as rats may exhibit sidedness, the proportions of right and left sidedness tend to be much more nearly equal in mature animals than in mature human beings. Yoshioka (1930) found equal proportions of left- and right-handedness in laboratory rats and a small proportion of ambidextrous individuals.

Tsai and Maurer (1930) recorded the handedness of 159 white rats, 105 physically normal and 54 vitamin-depleted. Two hundred fifty observations were made of each animal in reaching for wheat germ through a small-necked bottle. Seventy-five-100 per cent usage rated the animal as right- or left-handed. Animals showing 50-74 per cent usage were classified as ambilateral (Table 12).

TABLE 12

Normal Rats

	59 Males	47 Females
Right	59	43
Left	26	37
Ambilateral	15	20

Vitamin depleted rats

	27 Males	27 Females
Right	48	33
Left	48	45
Ambilateral	4	22

All of these rats had been the subjects of daily maze running experiments. The maze running of the vitamin-depleted animals was inferior to that of the normal rats. The experimenters concluded that "Left-handedness is higher among the poor learners." Unfortunately the full records of responses for reaching are not given so that it is impossible to convert these data into more precise indices of handedness and to make a distribution curve comparable to that for the apes of the Finch study (see below).

Animal behavior is less specialized, selective, and discriminative than that of the mature human individual. In this respect, man's hands match his brain, just as the animal mind and body structure are mutually adjusted. Furthermore, at birth the human infant's behavior is less predetermined; he is more amenable to instruction, training, and social conditioning than the lower animals, and the developmental process is much longer in proportion to his total life span.

17. *Chimpanzee Handedness*

The closer proximity of the great apes to man in the evolutionary scale affords comparative data that are of great interest and value in studying human handedness. Monkeys and apes possess a higher degree of manipulative skill than less highly organized animals and they have the advantage of greater independence in the use of the fore limbs as tools.

The most thorough study of handedness of the great apes has been made by Finch (1941) who tested and observed chimpanzee handedness in the Yerkes colony with thorough-going scientific methods. In the experiments the animals procured fruit through small apertures in a wire netting. The distribution for 800 trials for each of the 30 animals tested is shown in Figure 4. Right- and left-handedness were found to be equally distributed.

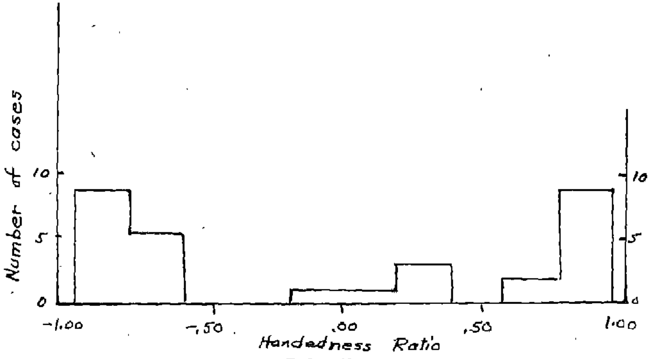

FIGURE 4

HANDEDNESS RATIOS FOR 30 CHIMPANZEES: DATA COMPUTED FROM FINCH (1941)

In this respect chimpanzees resemble the human infant. They do not attain dominant right-handedness to a greater degree than chance would allow even though their keepers are predominantly right-handed, and they do not develop much dexterity in the complementary use of the two hands together in tool using. Compare this curve with that for human handedness, Figure 3.

Infra-human animals are ambilateral. Handedness is the outgrowth of human intelligence and of man's intellectual development. The ape does not possess the mental ability to learn dextrous, highly specialized use of the hands. The apes are also lacking in symbolic language.

(*To be continued*)

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THE DEVELOPMENT AND TRAINING OF HAND DOMINANCE: III. ORIGINS OF HANDEDNESS AND LATERAL DOMINANCE*[1]

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What is the origin of laterality in man? Many theories have been advanced to explain sidedness and the prevalence of right-handedness in our society. Parson (1924) listed nine of the principal theories that have been proposed to explain handedness. Wile (1934) also has an extensive discussion of this subject. Specialists have tended to view the problem from the standpoint of their respective fields; for example, the physiologists, neurologists, and medical experts tend to look for constitutional factors; psychologists and educators lean more toward explanations in terms of learning and habit formation.

The recapitulation theory, which states in essence that the individual's growth follows the course of evolutionary progression of the human race tended to get in the way of the earlier experts who worked on handedness problems, although an increasing amount of genetic data tends to suggest that in broad outline, at least, the child covers in a few short months racial development achieved during centuries of time.

Another factor that has obscured clear thinking on the problem and has biased the interpretation of the facts found was pointed out in an earlier chapter; that is the persistent efforts of workers to discover the child's "real," "true," native or "natural" handedness, the assumption being that individuals show both natural and acquired handedness tendencies. When "natural" handedness could not be detected it was considered to have been covered up or overcome by rigorous training. The experts have debated the question: What is man's natural state of handedness?

A. CONSTITUTIONAL FACTORS

Considerable effort has been made to determine whether there are constitutional factors that predispose an individual toward dominant handedness and laterality. Many authorities have contended that the bias in which

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[1] The references are printed at the end of Part V.

dexterity originates must be traceable to some specialty of organic structure.

All efforts to identify some bias in anatomical structure that would account for lateral dominance have failed. As soon as confirmatory data are presented, contradictory data are produced. The difficulty with most theories based on constitutional factors is that the physical measurements used in the research on which the theories are based have been made in later childhood or adult life after handedness habits have long been established.

Any bodily anatomical or postural asymmetry shown in infancy tends to be right- and left-sided in equal proportion in the population. No preponderance of right asymmetry has been found at birth or in early infancy that would be sufficient to account for right-handedness.

W. F. Jones attempted to discover native handedness through arm measurements (1918). His conclusion on the basis of measuring 10,000 persons ranging in age from infancy to old age was that the bone measurements reveal born handedness. Jones concluded that one could pick out the right handers at birth from physical measurements of arms, wrist, hand, palm, using his Brachiometer. From these results, he asserted it was easy to classify individuals as pure right-handers, pure left, and transfers.

Beeley (1918) repeated Jones' work with children ages six to nine and found for ulna measurements: 46 per cent right-handed, 40 per cent left-handed, and 14 per cent doubtful or ambidextrous. Combining both ulna and humerus measurements: 46 per cent right-handed, 40 per cent, and 14 doubtful or ambidextrous. Yet in questioning these same children and their teachers as to the most used hand, 94 per cent proved to be right-handed, 3 per cent left-handed, and 3 per cent doubtful or ambidextrous. Beeley questioned the validity of a test that found only 46 per cent of persons right-handed in an ordinary population.

Whipple (1915) showed that strength of grip, tapping, and tracing tests did not reliably distinguish between right- and left-handers. Dynamometer data compiled by Galton for 6,992 individuals, six to 81 years of age, were analyzed by Woo and Pearson (1927) who found 64.62 per cent dextrality, 28.79 per cent sinistrality, and 6.59 per cent ambilaterality. They concluded that functional differences between the two hands are always more evident than structural differences.

In measuring visual acuity a bell-shaped distribution curve was obtained with 28.82 per cent dextrals, 54.79 per cent ambilaterals, 22.39 per cent sinistrals. Strength of grip for the same population was: 64.37 per cent dextrals, 6.73 per cent ambilaterals, 28.9 per cent sinistrals (Woo and Pearson).

B. Position of the Foetus in Uterine Life

Position of the foetus in intra-uterine life has been suggested as a predisposing factor in handedness. J. B. Watson believed that posture during the period of foetal life might have a pre-determining tendency toward the use of one hand in preference to another. Before birth the left arm lies posteriorly and this position might give the right hand greater facility of movement than the left. However, at birth there is no demonstrated preference in the infant population.

Postural relationships between infant and mother have been suggested as laterality determinants. If mothers more often hold the child to the right breast or in the right arm, and the child puts his left arm around the mother's neck, then the right hand would be free for manipulation. But until someone makes a thorough study of infant handedness and maternal postures this theory like the others remains questionable.

C. Visceral Distribution and Displacement of Gravity

Physiologists have suggested that since the center of gravity in the body tends to be toward the right, this tendency may be a predisposing factor in laterality; yet the distribution of the viscera in apes, who are ambidextrous, is similar to the distribution in man. Furthermore, persons with transposition of heart position are not correspondingly reversed in handedness.

D. Eye-Dominance Theory

Gould (1908) advanced the theory that dominant handedness originates in dominant eyedness, and that eyedness is an index of native handedness; but Gould apparently did not collect much evidence concerning eyedness tendencies in the general population. This was done by Parson, who used a manoptoscope that he devised for the purpose. About one-third of the child and adult population was found to be left-eye dominant in unilateral sighting tests. Parson concluded from this finding that man is at least 30 per cent natively left-handed. He explained the discrepancy between handedness and eyedness in later years as due to social pressure that trains away from the use of the left hand. Parson concluded that the sighting eye determined handedness, the effect being attributable to a functional limitation of binocular vision which necessitates the exclusive use of one eye for all sighting and aiming operations and therefore for many of the most important manual activities. According to Parson, the reason the child puts out his right hand to grasp an object is because his right hand is closest to and directed by the dominant right eye.

Other workers, using the same or other instruments for measuring dominant eyedness, have found from 25 to 33 per cent of the population to be left-eyed and have concluded that since there is a marked discrepancy between dominant eyedness and hand usage, eye-dominance cannot be considered the sole contributing cause.

According to Parson, all right-handed, left-eyed individuals are those who were originally left-handed but were forced to change, but the theory does not explain the opposite group, the left-handed, right-eyed.

Other authorities, in contrast to Gould and Parson, hold that right-eyedness is a condition concomitant with right-handedness and that both are dependent on the same or related causes.

Selzer (1933) believes that Parson's theory of eyedness as the *determiner* of handedness is hardly tenable. Others argue that this theory is untenable because in binocular vision it is impossible to distinguish the field of vision of one eye from that of the other. To all intents and purposes the two eyes function as one. Another argument against eye-dominance as a causal factor is that ocular dominance cannot explain the handedness of the blind.

E. CEREBRAL DOMINANCE, LATERALITY, AND HANDEDNESS

A popular explanation of sidedness and left-handedness is: a neurological condition due to the asymmetrical functioning of the two cerebral hemispheres, one hemisphere of the brain playing the dominant rôle in determining sidedness. According to this theory, handedness is due to the dominance of one cerebral hemisphere.

In the normal cerebrum the two bilaterally asymmetrical hemispheres are connected by nerves to the limbs on the two opposite sides of the body. The nerves are crossed, those from the left hemisphere passing to the right members and vice versa. The retina of the eye is connected to both crossed and uncrossed nerve fibers. The assumption is that motor controls for the dominant side of the body are grouped in the dominant hemisphere. The belief is that if both hemispheres operated indiscriminately confusion might result. In simplest terms, which can be understood by children, "two halves of the brain may be squabbling over which is to be the boss" (Orton). Vacillation would be certain if the two hemispheres functioned equally (Hall and Hartwell).

This theory of cerebral dominance was advanced as early as 1861 by Dr. G. M. Humphrey at Cambridge University. Around 1870-90 Brown-Sequard and others reported on cerebral localization and raised the question, "Have we two brains or one?" Le Conte (1883) proposed the explanation that people are right-handed because they are left-brained.

Proponents of the cerebral dominance theory claim only functional differences in the cerebral hemispheres, not structural or biochemical differences, because of their failure to detect any structural differences that are marked enough to account for dominance. As Parson states it: Any superiority which is generally recognized is purely functional and is unaccompanied by discernible structural peculiarities. No anatomical basis has been found for localization of cerebral centers. Cunningham could not discover any structural character to account for the functional superiority of the left cerebrum; and Southworth found no discernible difference in the distribution nor in the quantity of cells and fibres of the two cerebral hemispheres. Alsberg and O'Connor, however, found that the left cerebral hemisphere was larger, heavier, better-developed than the right.

According to Orton (1937), it is only in man that this cerebral dominance is shown, and in man, only in language and more intricate manual skills in which this specialization occurs. In these activities the two hemispheres can function quite independently of each other. Observations of clinical cases show that in people without established hand dominance, the language mechanism is also unlateralized in the cerebrum (Chesher, 1936). Actually the only guide to indicate which is the dominant hemisphere is the laterality of the individual exhibited in his sidedness and disturbances of function in aphasia and brain lesion cases. Even this evidence gives conflicting results. Complete cortical dominance has not been proved. The left-hemisphere in right-handed persons cannot be considered "dominant" for all nervous functions.

Kelly (1935) concluded that there is no known check on cerebral dominance which is sufficiently dependable to enable one to investigate the influence of that factor on the orientation of symbols as in reading and writing. He expressed the belief that the inference of a dominant hemisphere based on the exhibition of a preferred hand was unfounded.

F. IS CEREBRAL DOMINANCE HEREDITARY OR ACQUIRED DEVELOPMENTALLY?

Cerebral dominance is thought to appear early in life and is believed by some experts to be transmitted by Mendelian laws of heredity. There is equally strong evidence that cerebral dominance is a developmental characteristic, emerging concomitantly with the strengthening of laterality through childhood. There is evidence that the infant at birth shows no cerebral dominance, and that the two cerebral hemispheres are equally good originally in the normal individual. Functional asymmetry appears to increase as the brain is used. Some authorities contend that handedness and sidedness are the primary condition that the superiority of one hemisphere is the result of hand dominance. Others believe that the interaction of hand and brain develops the relative functional superiority of both simultaneously. If that is so, cerebral dominance could scarcely be considered the *cause* of laterality but rather an accompaniment.

G. EVIDENCE FROM PATHOLOGY OF THE RELATION BETWEEN SIDEDNESS AND BRAIN FUNCTIONING

The theory of brain dominance as a causal factor in sidedness rests largely upon brain pathology. Clinical cases of aphasia and locomotor disturbances due to paralysis affecting one side of the body are accompanied by defects in the motor discharges of the opposite side of the brain. Injury to the dominant hemisphere may cause paralysis.

When one hemisphere is damaged by injury or disease in childhood or later, above the infant level, some incapacity in handedness results to the opposite side. The disturbance is proportionate to the extent of the lesion or injury. The fact is well established that in adults a serious injury in the motor speech area in the dominant left hemisphere may cause loss of power of articulation in the right-handed.

Cerebral dominance is more complex than has been thought; it is not itself a function, but simply a name for the fact that speech and allied functions are located in the left-hemisphere (for the right-handed) (Brain, 1945).

There is no such thing as a direct, unvarying relationship between dominant sidedness and dominant control in the opposite cerebral hemisphere. The various body functions behave independently of one another in relation to hemisphere dominance and in the case of any one of them the functions normally performed by the left hemisphere may be transferred to the right without shift in others.

When the left cerebral hemisphere is damaged early in life the right hemisphere usually assumes the speech functions of the left. In children impairment is not permanent. The other hemisphere takes over and develops the lost function (Brain, 1945). The entire cerebrum is involved in speech. In adults, bilaterality is maintained after half of the brain is removed. Learning factors involving the cortex and associated processes are involved.

Handedness is important for neurological diagnosis because it enables the examiner to determine in which hemisphere the lesion responsible for aphasia is situated. Aphasia from a lesion affecting solely the left hemisphere is seen only in those cases in which the patient has already learned to write with the right hand. In illiterate adults aphasia may ensue from lesions on either side (Burt).

Although automatically and structurally there is a high degree of localization, functionally the brain operates as a unit. It is organization rather than certain areas that are upset by lesions. Patients show recovery from aphasia, suggesting that the minor side of the brain takes over the language function. It is difficult to discover in clinical and surgical studies any phenomenon of sidedness that can be attributed to lateral cerebral dominance.

No sooner is evidence offered in support of the cerebral dominance theory as a cause of laterality, than equally strong evidence is offered to the contrary. The neurological evidence in man and that gleaned from the lower animals suggesting the theory of cerebral dominance as *cause* of handedness rests on weak foundations. Burt considers the assumption of mutual inhibition between the two hemispheres of the brain to be far-fetched.

Ballard suggests that eye-dominance tests cast doubt on the cerebral dominance theory as an explanation for all sinistral or dextral behavior. The anatomical relation of the eyes and the two hemispheres is very different from the relation between the hands and the hemispheres. The two halves of the retina are represented in both cerebral hemispheres, so that impulses from each are intermingled with those from the corresponding half of the other retina.

Twitmeyer and Nathanson (1933) held that since consistent laterality does not exist, doubt is thrown on the complete cortical dominance theory. The issue cannot be settled without more searching studies of behavior at all stages of development in relation to brain pathology.

H. Is Hand Dominance Hereditary?

Hand dominance is commonly assumed to be hereditary because it is difficult to explain in any other way. Whether or not handedness is hereditary is an important question because the viewpoint taken affects one's attitude toward handedness in early childhood. Those who hold that handedness is hereditary believe that attempting to change a child's left-handedness would be futile if not dangerous because it would be "going against his nature."

The question of hereditary handedness also has a bearing on the common practice of attempting to determine an individual's "native," "original" or "natural" handedness. More than one worker has pointed out the need for careful individual testing to make certain "which is the hand nature meant the individual to use."

Those who have seen children damaged by enforced efforts to "change over" tend to subscribe to the hereditary origin of handedness if only to protect the child. On the other hand, by using heredity as an explanation, the child's parents and teachers feel absolved from responsibility for training and also for the adjustment difficulties the child experiences. Persons who subscribe to an explanation in terms of heredity tend to take a fatalistic attitude toward the whole question. One parent argued that his child was destined to be a left-hander because the grandfather was. Another parent, on learning that the school wished to correct the child's awkward left-handed writing, protested to the teacher: "For generations in our family there has always been a case of that rare, crooked-wrist left-handed writing. Our daughter Julia is that case in the youngest generation and we don't want anyone to attempt to change her."

I. EVIDENCE CONCERNING THE HEREDITARY NATURE OF HANDEDNESS

Many authorities have expressed the belief that handedness is hereditary and have offered evidence to support this view. A summary of reports on this topic will be found in Parson (1924).

Beeley (1918), Rife (1922), Ojemann (1930), Wile (1934), and Orton (1937) all concluded that the available evidence proved left-handedness to be an hereditary characteristic, for they believed that only in that way could the tendency be explained. Gordon (1920) and Wile concluded that left-handedness is inherited like a Mendelian recessive trait, one out of four children being natively left-handed. Scheidemann (1931) observed that experiments in early training suggested the independence of training and handedness.

Freeman (1942), too, subscribes to the theory that dominant handedness is inherited. According to Freeman, the evidence lies in the fact that preference appears very early, the superiority of one hand over the other is frequently very great, there exists a small group who are more skillful with the left hand in spite of all teaching and influence to the contrary.

Chamberlain (1928) reported that when both parents are right-handed only 2.1 per cent of their offspring are left-handed, but that when both parents are left-handed the incidence of left-handedness rises to 17.34. These data were offered as an argument favoring heredity.

Brain (1945) holds the customary view that the most important cause of handedness is hereditary; must people are right- or left-handed because of the structure of the genes they have inherited. He believes, however, that handedness cannot be regarded simply as an hereditary character; innate handedness may be obscured by training. .

Gould (1908) believed that there was no endowment of right- or left-handedness as a completed, matured mechanism and he refuted the belief in handedness as a Mendelian trait.

A common conception is that in many individuals an artificial or unnatural dominance has been superimposed, through training, on the natural inclinations of the individual. Since man's behavior in contrast to that of the lower animals is highly modifiable and less predetermined at birth, any hereditary bias can be overcome through training.

Orton (1937) observed that handedness is so much subject to the influence of training that the resultant pattern is a combination of hereditary bent and the effects of training. He says:

> When right-handed training of a natural sinistral has been instituted very early, the usages acquired through a number of years of such training may effectively hide the natural bent, and such cases of "masked-handedness" can often then be recognized only through the use of motor tests for measuring untrained skills.

Parson concluded that there were two types of handedness, (*a*) congenital or native and, (*b*) handedness acquired through corrective educational measures or as a result of injury or disease. He believed the initial bias to be so slight in infancy that training could easily overcome the initial bias so that children who are left-handed originally become right-handed through training.

Durost (1934) believes the weight of evidence favors inheritance as against purely environmental determination of functional laterality, but he found the preferential use of either hand to be so much a matter of training and environmental pressure that any measures of preferential handedness would not be likely to yield results following known laws of inheritance. Durost concluded that (*a*) the influence of environment begins at the moment of conception, and (*b*) handedness calling for considerable specialization of the nerve cells may be a matter of delayed maturation.

In his earlier writings Gesell was inclined to consider handedness as inherent in the constitutional makeup of the individual. More recently (1940) he expressed the view that whether or not handedness is native or acquired is unknown. In 1947 he says, "Handedness is the product of growth."

Others express the belief that if heredity is the cause of handedness it is operating according to some unknown laws. Dr. Burt concluded that the inherited bias must be comparatively slight. Otherwise it would not be so difficult to substantiate. He is inclined to believe that all forms of left-handedness are only indirectly hereditary. Post-natal influence always enters into the picture.

In Burt's opinion, explanations in terms of heredity deny the immense rôle of training and environmental conditioning from early childhood. If there is some hereditary predisposition it is certainly far outweighed by environmental influences. The child may simply have copied his parent. Burt (1937) says that psychologists are far more chary of admitting heredity as an explanatory principle than they were 20 years ago.

Many years ago, Sir William R. Gowers held that children are born with equal tendency to use the right or left hand, one's handedness being brought about in the course of growth and development, partly from hereditary, partly from environmental influences, with the latter the more important. Initial bias is either confirmed or suppressed by social tradition because the culture favors right-handedness.

Kellog concluded from his experiments with his infant child and an infant chimpanzee that handedness either was not inborn or that the tests and observation methods he used were not refined enough to detect hereditary laterality.

The most that can be said is that heredity furnishes the normal human infant with two hands and arms that are about equally responsive to training and an active mind that is capable of learning complex motor adjustments. In cases of hereditary mental retardation, left-handedness may persist because all training in these cases is difficult.

J. Developmental and Social Conditioning as a Cause of Hand Dominance

The explanation that seems best to fit the facts is that handedness is the product of developmental integration. People are right- or left-handed because they have learned to be, not because they were born that way. Handedness is habitual behavior influenced by circumstances operating throughout the growth period. Modern authorities have concluded that there is no such thing as natural handedness that is observable in early childhood, consequently attempts to discover a child's native or congenital handedness and to distinguish between native and acquired handedness are futile.

Acquiring handedness follows the laws of learning and habit formation just as any other behavior that results from practice and exercise; the laws of exercise and effect, the principle of individual differences and the like are operative. Every experience strengthens and predisposes the organism to the next similar motor discharge. The processes at work in infancy are differentiation, specialization, and organization. Habit is formed through repetition; in the case of handedness, through repetition of the initial accidental chance hand usage or other conditioning circumstances.

Orton prefers to use the term "developmental" rather than "congenital" in speaking of handedness because congenital understresses environmental factors, methods of teaching and the like, both specific and general.

Koch concluded that handedness is a trait influenced by many variables among which are instruction, example, convenience, obviousness of choice, previous habits, the specific nature and familiarity of the tasks to be performed, hand strength and genetic factors. Strong, constant, biasing forces are at work.

After a thorough survey of the literature on the subject, Downey (1933) could find scarcely a shred of evidence that handedness is hereditary; she expressed the belief that handedness is the product of social cultivation, the result of habit and custom. It was her opinion that training factors, both specific and general, had not received the attention they deserved.

The parents and the child's early environment are his teachers in acquiring handedness just as they are for speech. In fact, there is a close parallel, if not actual relationship, between the two skills. The attitude of the parents and the degree of influence and control they exert over the child are the strongest training factors in the majority of cases in the early years. Children show strong imitativeness of observed movements, a trait which plays a large rôle in motor learning. They mimic the actions and gestures of their elders often without their parents' awareness, responding to slight suggestion almost unconsciously.

Earlier research tended to overlook social conditioning as a causal factor in handedness because few infants were accessible for continuous observation. Physicians and others who dealt with clinical cases saw chiefly patients with long-established psycho-motor habits. Those who worked with adults and older subjects favored heredity as an explanation because handedness appeared to be so deeply ingrained. Teachers were concerned chiefly with the handwriting habits of children. As soon as better genetic studies were made, research workers began to favor explanations in terms of experience, training, and culture. The infancy and early childhood data have been invaluable in demonstrating the rôle of training in hand usage.

From his study of infants, J. B. Watson (1919) concluded that handedness was not instinctive nor even structurally determined but socially conditioned. It is his belief that there is no innate tendency to use one hand more than the other. Preference is determined by early experiences and by subsequent formation of habit based on this experience. Watson is convinced that handedness forms but another instance of an artificial habit due to conditioning. He says: "Our whole group of results on handedness leads us to believe that there is no fixed differentiation of response in either hand until social usage begins to establish handedness. We instruct infants to shake hands with the right hand, to wave 'bye-bye' and to eat with the right hand."

Handedness habits are acquired in infancy and early childhood through conditioning without awareness that habits have been formed. Furthermore, the infant learns his first psycho-motor habits without exerting conscious effort to learn. The fact that the child attains hand preference early and incidentally makes for security in these habits. By three years of age these habits are by no means slight or unstable in many cases. The increase in right-handedness from birth to maturity is a typical learning curve.

K. SUPPORT FOR THE SOCIAL DEVELOPMENTAL ORIGIN OF HANDEDNESS

The social-developmental theory of the origin of handedness suggests that with early and long continued training during the childhood years all individuals except pathological cases could become either dominantly right- or left-handed. Support for this theory lies in the following facts:

Young children are easily trained away from left-handedness. Training could not have so much influence if the hereditary factor were strong.

There is little resemblance between the handedness of parents and their offspring. Few families show similarity in handedness through several generations. In a survey of left-handed children Schafer (1911) found 16 per cent of the parents, 8.2 per cent of the grandparents, and 2.5 per cent in the third ancestral generation to be left-handed. Even if more relationship were found handedness could not be inferred because a child may merely have imitated his elders in the family circle or have been trained like his parents.

Most individuals show inconsistencies in handedness. Few persons show a consistently high degree of sidedness. Eye and hand dominance are not in agreement in a substantial proportion of the population. Footedness is never as pronounced as handedness.

Identical twins tend to show same-sidedness in later childhood, not mirrored handedness as they would if heredity were the determining factor.

Left-handedness sharply decreases from infancy to adulthood.

Young children show great inconsistency in handedness. Right-handedness prevails for trained skills such as eating; neither-handedness for random acts.

Boys show greater proportions of left-handedness than girls, a phenomenon that evidently has a social origin.

Another argument for the environmental origin of handedness is that untrained animals are ambilateral.

Left-handedness has increased during the past few decades with modern methods of child training in home and school that give more scope for freedom in activity and self-adjustment.

The proportion of left-handedness varies with the cultural climate in which the individual grows up, especially with respect to eating and other social customs.

Eyedness remains more nearly 50-50 in childhood because no social stigma is attached to left-eyedness.

The increase in left-handedness from infancy to maturity is probably due to the cumulative effects of direct or indirect training. This also explains why left-handed two-year-olds are so hard to find.

Mental defectives tend to be more nearly 50-50 in right- and left-handedness or ambidextrous because they are less trainable.

The skills in which people tend to be most definitely right-handed, e.g., eating and writing, sewing, and throwing, tend to be those most definitely taught and drilled.

Training proves to be effective in improving the dexterity of the non-preferred hand above the nursery years. When training is given to both hands separately the non-preferred hand makes the greater gain. In some cases the left improves from two to three times as much as the right. Bowman (1928) gave 35 trials on a pegging test to right- and left-handed subjects. During the test series the right/left ratio declined in the right-handed subject and increased in the left-handed. In an experiment with pegging tests conducted by Downey, special training given resulted in a decrease in the ration of right-handedness, an increase in left-handedness.

New skills are learned by older children and adults as easily with the left hand as with the right. A boys' club leader said that he taught his beginners in basketball to shoot with the left hand since this was an advantage many times in the game and the boys had no trouble learning it. Dr. Orton observed how easily one could become left-handed for a given activity by imitation. A youth saw a left-handed pole vaulter and copied the action. He never could change back to the right hand for this sport.

Experiments with physically handicapped and amputee cases show that with suitable teaching the left hand can be trained to take over the functions of the right.

During the period that Kellog trained both the child and the infant chimpanzee to eat with a spoon, they both developed right-hand preferences, though before this period they had showed slightly more preference for the left hand.

Training tends to eliminate the socially disapproved left-handed acts more quickly than those not disapproved. In fact, the latter may never be affected by direct social censure at all, e.g., stirring food in a kettle or wiping dishes.

We hear of children who early showed some tendency toward left-handedness in unilateral activities but "outgrew" it before school age. These are the children who were trained by parents and nurses or who trained themselves to right-handedness through imitation.

In a series of experiments, Dr. James Shaw placed articles persistently in the left hands of two ambilateral children who developed such proficiency in left-handedness that it was almost impossible for them later to develop equal proficiency in the right hand. Children who learn abroad to eat with the fork held in the left hand have difficulty relearning the skill with the opposite hand.

If chance factors operated impartially and there were no cultural bias people would tend to be about 50 per cent right-handed and 50 per cent left-handed at maturity. Selzer (1933) among others has suggested this probability.

L. EXPLANATION OF PERSISTENT LEFT-HANDEDNESS

If heredity is not the primary basis of left-handedness how then can the persistence of the trait in a small proportion of the population be explained? Factors that condition nursery age children to left-handedness were indicated in Chapter III.

There are several sets of factors that account for left-handedness appearing and persisting in a small proportion of the population.

1. Incapacity due to illness, accident, or physical defect. A small proportion of the population have lost the use of the right hand due to accident or illness or have become partially incapacitated. A child may be forced to use his left hand due to cerebral palsy resulting from birth injury or the after effects of encephalitis or meningitis which has caused damage to the brain tissues and the neuro-muscular apparatus. Fifty per cent of these cases are spastics with tense muscles or involuntary movements, lack of balance, and muscle incoördination.

Dr. Brain (1945) calls attention to the difference between "natural" and pathological left-handedness. The latter occurs in an individual with a brain lesion. Congenital abnormalities or injuries, or diseases such as hemiplegia or hemiparkinsonism may force the individual to become left-handed.

2. Mental retardation. Mentally retarded children show more left-handedness than those who are mentally normal as the data in Chapter IV indicated. The reason is that mentally retarded children are slower than others in responding to environmental clues and to direct training of parents and teachers. They are also slower in learning motor coördination and the use of tools.

3. Direct or indirect training and force of habit. Some parents on observing ambilaterality in a nursery age child conclude that the child is left-handed and deliberately train the child to preferential choice of the left. A case of this sort was cited in Chapter III. Because most persons have the notion that left-handedness is hereditary the trait is not discouraged, but rather encouraged. This encouragement amounts to training. In other cases the children train themselves through repeated practice when there is no interference. Children sometimes voluntarily begin to write with the left hand when they see that left-handed children in a class get special attention from the teacher. The "leftie" tends to cling to the trait not necessarily on account of stubbornness but because the habit has become entrenched. Some children imitate their left-handed parents or their older siblings.

4. Emotional resistance. Persistent left-handedness may be a sign that the child is defiant or resentful of those in authority over him and he may use the trait as a means of asserting his will. For some children left-handedness is obviously an attention-getting device. One child clung to his left-handedness during the school years because the trait singled him out as an individual who was "different." Another gained satisfaction from being singled out as a "rare sinistral cast that reverses everything." A child may show a subconscious trend toward fixing and exploiting an abnormal sign. Developing skill in doing things backwards is an illustration.

Some of the family conditions that may increase a child's emotional resistance and thereby reinforce left-handedness are: jealousy of someone in the family, sense of being oppressed by strict adults in the family circle, insecurity or anxiety due to struggles between parents, and over-anxiety shown by a parent concerning a child's behavior.

It is difficult to say whether the neurotic symptoms are contributing causes or the effects of sinistrality. Any child will resent and reject attempts to interfere with established motor habits. This negative resistance shows up particularly after four or five years of age. Resistance may be only a sign that unpsychological methods have been used in training.

M. Ocular Dominance and Handedness

Most people who are fully aware of handedness do not realize that they also show sidedness with respect to ocular adjustments. People are dependent on vision for precision in skilled manual performance. Binocular vision enables one to gauge depth and distance as well as to perceive three-dimensional form. Binocular vision comes into play in all bodily movements that are directed by vision. In using hand tools and implements (e.g., in hammering a nail, threading a needle, or throwing a ball) the eye, the hand, and the point of regard must all be brought into alignment.

Binocular vision occurs when the eyes are so turned by the muscles that the two lines of sight meet at the point of regard and the two images are focused into one clear-cut picture. Objects within the field of vision not at the point of regard tend to be seen as double. To test this phenomenon hold the forefinger at arm's length before the eyes and fixate a distant object. In binocular vision it is impossible to distinguish the field of vision of one eye from that of the other.

Dr. Joseph L. Conte (1883) pointed out that few persons possess pure binocular vision. The images seen by the two eyes are not identical. When both eyes are open one of the images is suppressed; one eye tends to do the directing and controlling.

According to Parson (1924), unaided natural vision is bilaterally asymmetrical and in matters of exact orientation we are virtually one-eyed, automatically disregarding the median line of sight and using the right or left field predominately. This tendency is shown both by school children and adults.

N. Eyedness and Laterality

This "master" eye, as Parson called it, is the dominant eye and normally corresponds with the individual's sidedness and lateral dominance in general. The hands, which are so largely dependent on vision for accurate movement, are forced to accommodate themselves to this radical deviation from binocularity, the one hand nearer the sighting eye being more important functionally. Since the preferred hand and eye are nearer together, thy can come into position more quickly than the hand and the opposite eye. This fact has some practical significance, for workers have difficulty in readjusting to working conditions if the dominant eye is lost. Of course, anyone suffers inconvenience if either eye is temporarily or permanently disabled. There are some persons who, instead of being strongly one-eyed, tend to be more nearly equal-eyed, just as some persons have no well-established hand dominance. In the ambi-eyed person, the sighting eye fluctuates from eye to eye as the need arises, as in apes, instead of showing the more highly specialized fixed type which characterizes most of the human race. According to Parson, this latter type developed as a result of man's activities as a weapon and tool user. People grade all the way from left-eyedness to right-eyedness with many intermediary stages in between. There are persons who must be recognized as left-eyed, right-eyed, equal-eyed, and unstable-eyed.

The unilateral sighting preference is much stronger in some persons than in others. It may vary with the particular situation requiring sighting. Furthermore, consistency of eye-dominance in an individual depends somewhat upon the nature of the tests used to measure it.

Eye-dominance is considered to be a significant feature of human development because of the relation between eye-hand functioning and problems of motor adjustment including speech, reading, writing, and certain vocational skills. These problems will be considered at greater length in Part IV. Determination of eye-dominance has become routine in clinical studies of adjustment problems. Methods of testing eyedness are described in Part IV.

O. EYE DOMINANCE AND VISUAL ACUITY

No relationship has been established between visual acuity and dominant eyedness. Eye preference is not caused by inferior or superior strength or efficiency of one eye. However, Blake Crider (1935) found that the eye with muscle inefficiency was seldom the sighting or dominant eye. Eyedness is not affected by the visual acuity of the eyes, for in many cases the master eye is weaker. Eyedness is primarily a matter of motor control.

P. CHARACTERISTICS OF OCULAR DOMINANCE

Eye movements develop in infancy ahead of hand movements. The eye tends to control and direct the hands in manipulative activity. Although as the Gesell data show, the infant gains control over eye coördination before he achieves hand control, it is doubtful whether unilateral sighting develops before hand control. Probably the two functions develop coördinately for a time before definite hand preference training begins. The time at which the hand breaks away from the eye-lead due to pressure to conform to the right-handed convention varies with the nature and onset of training. Vision plays a still greater rôle in spatial orientation as the child begins to walk.

Apparently children, like apes, are ambi-eyed at birth and for some time after, but eye-dominance develops as a function of maturity as soon as sighting required in the use of implements begins. At that point the eye and hand function coöperatively. Eye-dominance like handedness increases to some extent with age, suggesting that eye preference is an acquired visual-motor habit and that it is modifiable. Ocular dominance is established in early childhood and, unlike handedness, from then on tends to persist unless the sighting eye becomes incapacitated.

Eyedness is not so obvious a trait as handedness, and is not directly trained or tutored as is the case with handedness because teachers and parents are not generally so aware of it. The choice of the sighting eye is purely involuntary, as are changes in dominant eyedness. There is no social convention favoring eyedness as is the case with handedness, consequently no pressure is normally exerted on the child to develop either right or left dominant eyedness.

Q. Eyedness as an Indicator of Handedness

Parson and others before him proposed that eyedness was a clue to handedness and could be used as an authentic test of "natural" or "native" handedness and lateral dominance of the organism in general. According to his belief, when discrepancies between eye- and hand-dominance occur, the eye dominance may be considered the surer indication of "original" or "natural" laterality, since the handedness tends to change through the growth period far more frequently than eyedness.

Eyedness is significant chiefly as an indication of early hand usage. The neurologist Brain does not believe that eyedness plays any part in actually causing handedness.

R. Incidence of Eyedness

Eye dominance is difficult to measure reliably because the instruments used to measure eyedness may be influenced by the subject's handedness.

Ballard (1911) found more nearly equal proportions of right- and left-eyedness when the handedness factor was eliminated in the tests. Individuals show a low but positive correlation between eyedness and handedness. The incidence for left and right eye dominance or preference shows little similarity with the data for handedness.

In a test of 877 New Jersey school children in which the Parson manoptscope instrument was used (1924) the results were as follows: 69.33 per cent used the right eye for sighting; 29.30 per cent, the left eye; 1.37 per cent, the right and left visual sighting lines impartially.

Data for the incidence of eyedness cited by Downey (1933) are given in Table 1.

TABLE 1

	Right-eyed	Left-eyed	Impartial, binocular or ambiguous
Parson	69.3%	29.3%	1.37%
Lund	69.8	25.5	4.6
Downey	73.0 (men) 64.6 (women)		
Cuff	62.3	28.8	8.9 (Parson method)
Cuff	72.9 (boys) 70.6 (girls) (by his own method)		
Miles	65.0	30.0	5.0
Snyder	64.0	21.0	

Of Koch's subjects (1933): 95 or 47.3 per cent were right-eyed, 54 or 26.8 per cent were left-eyed, 52 or 25.9 per cent were different-eyed in the two trials of the test.

Smith (1917) did not find a high correlation between handedness and eyedness. The traits seemed to be unrelated. Seventy and three-tenths per cent of the subjects showed right eye-dominance.

In a study by Miles (1930), 64 per cent of the adults were right-eyed, 34 per cent, left-eyed. Two per cent showed no well-marked eye dominance. In right-handed individuals, one-third or slightly more were left-eye dominant. In the left-handed, eye dominance was more nearly fifty-fifty.

In an experiment conducted with children between six and 11 years of age in which two eyedness tests were used, 49 per cent proved to be right-eyed in both tests, 39 per cent left-eyed, and 12 per cent were left-eyed on one test, but right-eyed on the other. The data for the Parson Manoptscope alone were: 52.3 per cent right-eyed, 47.7 per cent left-eyed (Hildreth, 1945). In a study of 549 Cambridge children Selzer found 36 per cent to be left-eyed (1933).

Johnson O'Connor collected records for 100,000 persons, mostly adults, and concluded from tests of eye dominance that 25 per cent were left-eye dominant. He concluded that most of these persons had been forced to use the right hand (Palmer, 1943).

Dr. Clarence Quinan tested University of California undergraduates and found that 26 per cent were left-eyed. Few, he reported, had any memory of being left-handed as children.

In summary, left-eyedness is more common than left-handedness. Children show more equal proportions of right- and left-eyedness in certain tests than adults.

Genetic studies are needed to determine the relative time at which stabiliz tion occurs for the sighting eye and for manual habits.

Due to the difficulty of studying eye-dominance in infancy and early chil hood, the developmental trends in eyedness have not been thoroughly e plored at these age levels. Investigation in these early levels would answ many perplexing problems concerning the development of the relation betwee eye and hand functioning.

S. THE RELATIONSHIP BETWEEN EYE- AND HAND-DOMINANCE

The association between eyedness and handedness is not very close, as Pa son's data show. Jasper and Raney (1937) found the correlation betwee handedness and eyedness to be little better than chance.

On an aiming test, Ballard found among 51 sinistrals 57 per cent of th subjects to be right-eyed, 43 per cent left-eyed. Among 41 left-handed chi dren tested, 23 per cent used the right eye in one test. In another experimen out of 60 boys, 46 were right-eyed, 14 left-eyed; of 74 girls, 48 were righ eyed, 12 were left-eyed. Fourteen failed to show eye-dominance.

Selzer found 44 or 72 per cent of 61 left-handed pupils in Cambridg schools to be left-eyed. Thirty-one per cent of the right-handed were left-eye

Oates (cited by Downey) found that among 194 left-handed boys, 52. or 27 per cent were right-eyed. Another worker concluded that the clearl left-handed are about equally divided between right- and left-eye dominanc but in the right-handed the great majority are right-eyed. Mintz foun more mixed dominance in subnormal than in normal children.

The correspondence between eye and hand apparently diminishes wit age, according to Burt. Among older children and students less than hal of the left-handers were left-eyed. Hildreth (1945) found that in scho groups ranging in age from six to 11 there was no change in proportio of right- and left-eyedness from younger to older age levels. Eyedness do not tend to change along with forced change of handedness after having bee established in early childhood. In infancy and early childhood, hand- an eye-dominance are in accord, but divergence appears with shift in handednes

Lack of agreement between dominant eye and hand is known as "mixe dominance." Anywhere from 20 to 40 per cent of the population show th characteristic depending upon the age when the individuals are tested.

Koch found that eye injuries or visual deficiencies did not account fo failure of agreement in eye and hand preference.

Lack of agreement which is commonly found in persons whose moto adjustments are entirely normal can be accounted for by the fact that dire and indirect training factors do not affect eyedness to the extent that they influence handedness, shifts in handedness do not affect eyedness, and the establishment of eye-dominance is apparently not so essential for performance of skilled tasks as is manual dominance.

T. MIX EYE-HAND DOMINANCE AS A SOURCE OF CONFUSION

There is widespread belief that "mixed" eye-hand-dominance causes spatial confusion. Parson looked with suspicion on any cases showing lack of agreement. He asserted that the best performance results when eyedness and handedness are coördinated on the same side. Wile, too, believed that lack of harmony between handedness and the sighting eye caused difficulty. Downey found that the combination of right-handedness and left-eyedness was a great disadvantage in orientation tests.

However, since 20 to 25 per cent of the population show some lack of correspondence between eye and hand in sighting and many of these persons experience no confusion or emotional stability due to "mixed" dominance, this factor has probably been exaggerated as a cause of adjustment difficulties. Lack of established eye-dominance or instability in hand-dominance may be the chief source of difficulty in confused cases; or the cause may reside in lack of well-established habits and adjustments, which tend to be reflected in mixed-dominance. The condition may be only an indirect and a relatively unimportant factor along with other behavior symptoms.

Learning difficulties attributable to "mixed" dominance are considered more fully in Part IV.

(To be continued)

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A LABORATORY INVESTIGATION OF MEASURES OF FRUSTRATION TOLERANCE OF PRE-ADOLESCENT CHILDREN*[1]

The Mooseheart Laboratory for Child Research

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A. The Problem

Experimental studies of human frustration have for the greater part attempted to identify and examine the principal adjustive mechanisms initiated by frustrating experience. The usual procedure has been to structure a frustrating situation in the laboratory and to make systematic observations of the behavior or certain segments of the behavior it induces. Mechanisms identified in this way have been interpreted in terms of (*a*) their *functions* with reference to the ends they serve in the individual's efforts to adjust to frustration (4), (*b*) their implications in the sphere of social interaction (3), and (*c*) their relation to behavior mechanisms observed clinically in psychopathological conditions and in certain stages of normal personality development (1, 2, 4, 7, 8, 9).

One of the more specific questions which has arisen in the analysis of adjustments to frustration is concerned with the adequacy of the response to a frustrating situation. Adequacy is gauged according to the adaptiveness of the response or its economy in establishing equilibrium btween the individual's needs and the realities of his environment. Since a number of different kinds of reactions to a specific frustrating situation are possible, certain modes of reaction may be expected to be more adequate than others. In his examination of this question, Rosenzweig (6) took the position that reactions to frustration may differ in their degree of adequacy and that it

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[1] Based on a report originally presented at the American Psychological Association Convention in September 1947.

[2] This investigation is an outgrowth of a coöperative study originally projected by Dr. Mandel Sherman's Laboratory at the University of Chicago and the Mooseheart Laboratory. However, the orientations and the standard method described in this paper as well as the findings are the authors'. Advice and encouragement by Dr. Martin L. Reymert, Director of the Mooseheart Laboratory, are gratefully acknowledged. Special credit is acknowledged to Mrs. Mary Alice Hansen, who conducted a corollary observation study on a larger group, including the subjects used in the laboratory investigation. Certain relationships between the findings of the two investigatons are included in the present report.

is possible to relate such differences to a psychological variable which he designated as "frustration tolerance." As a working definition he suggested that frustration tolerance be identified as "the capacity of an individual to withstand a given frustrating situation without distorting the so-called 'objective' facts of the life situation" (6), or, as subsequently stated, ". . . without failure of psychobiological adjustment, i.e., without resorting to inadequate modes of response" (10).

Rosenzweig considered the possibility that research in this area might eventually make possible the establishment of standard experimental procedures to yield a quantitative index of an individual's frustration tolerance comparable to existing procedures for intelligence determination. It is significant, however, that he did not overlook the possibility that frustration tolerance might not emerge as a general characteristic but might be found to exist in differing degrees in the various aspects of the same personality (9). A possible correspondence of "circumscribed areas of low frustration tolerance" to Freudian "complexes" was hypothesized. Such stimulating theoretical suggestions imply a new approach to personality diagnosis, one which focusses attention upon the actual demonstration, through an experimental behavior—sampling procedure, of the adjustive mechanisms at an individual's disposal in the face of obstacles. The adequacy of such mechanisms—whether they follow the form of healthy or neurotic solutions; integrated, adaptive behavior or disorganized, non-adaptive activity—can be seen as expressions of personality adjustment which are clinically relevant and at the same time accessible to evaluation through the laboratory-experimental approach.

B. CONSIDERATIONS OF EXPERIMENTAL TECHNIQUE

One of the pioneering laboratory investigations concerned with the quantifying of frustration reactions was that of Sherman and Jost (11). Their study was "designed to investigate the problem of the standardization of experimental conditions in the production and measurement of frustration in children and adults, and to compare the responses of normal with those of neurotic persons." Detailed findings were reported on two groups of children: a control group of 18 well adjusted children and an experimental group of equal number including 15 who were seriously maladjusted or neurotic and three who were diagnosed as schizophrenic. The task designed to produce frustration consisted of the learning of sequences of digits by an anticipatory method (e.g., guessing each member of a series before it was flashed on a lighted panel, with repeated presentations to permit learning of the easier series). The first two sequences were easily learned but were followed by sequences which were too long for any of the subjects to learn. The experimental frustration was associated with the unsuccessful attempts of the subjects to learn the number sequences which were beyond their levels of ability. The subjects were given the same number of trials on the sequences which they failed as the number they required for their successes on the control series. Each subject was assured that the task was not difficult and that others had learned the number series very quickly. While behavioral data were recorded, the emphasis was placed on physiological reactions measured with the aid of a Darrow photopolygraph and an electroencephalograph. These measures included galvanic skin resistance, respiratory rate and amplitude, pulse rate, blood pressure, hand tremors, gross bodily movements and the *EEG*. The rationale for giving greater weight to physiological measures than to overt behavior changes was in terms of the assumption that outward expression is not as dependable an indicator of experienced frustration as the less readily controlled physiological reactions. These latter reactions were felt to be the most accurate indication of "the point at which frustration occurs."

The investigators found a significantly different pattern of physiological reactions between the experimental and control groups, both during frustration and during the control periods before frustration. As a group, the neurotic individuals reacted more intensively to the frustrating situation than did the normals. The frustration reactions of certain of the neurotic children were difficult to evaluate, however, because of an apparently continuous tension even during the control period.

While the investigation of Sherman and Jost seems to represent a significant exploration of the possibilities of quantifying individual and group differences in frustration tolerance, the present authors recognize a need for the standardization of a more sustained and more uniform frustrating situation and for a more detailed analysis of some of the psychological factors involved. It is evident that transitory frustrations do not lend themselves to as adequate an analysis as more sustained ones. The digit-sequence tasks employed by Sherman and Jost tend to break up the experimental frustration into discrete series of frustrations, in each of which the failure experience takes place relatively quickly and is then dissipated to some extent by the redirection of effort onto a new task. The frustrating experience might have been made more sustained had the experimenters required the subjects to persist longer with repeated trials on any one of the failure sequences. The fact that they were given only as many trials on a failure series as they required for the shorter success series not only would be expected to make the frustration more transitory but would also provide the subjects with a ready-made rationalization of their failures (e.g., not being allowed more time when the difficulty of the task is increased). Equating the number of trials for failure tasks with those required for success on the control tasks presents still another difficulty; namely, an inter-subject variability in the severity of the frustrating situation. Such variability arises from the lack of uniformity in working time spent by the various subjects both on the control and frustration tasks, which is a function of individual differences in rate of learning. It is a methodological difficulty inherent in the use of any real learning situation as a source of experimental frustration. In the present investigation a solution of this problem was attempted by devising a pseude-learning situation in which the time spent for success (control) and for subsequent failure (frustration) was held constant for all subjects. This was done by varying the difficulty of the control task to permit all subjects to succeed after a constant time interval and by requiring all subjects to work for a fixed time on the frustration task on which success was made impossible. The kind of task employed in the present investigation is one which has methodological advantages over the kind used in the experiment cited. A more sustained frustration was established by employing a motor learning task (stylus maze) in such a way that the frustration was developed in the course of a single uninterrupted trial lasting 10 minutes without any opportunity for success. The task was also one which lent itself more readily to experimental control of trial time without the subject's awareness.

While the present experimental design succeeded in establishing an objectively uniform, sustained and effective frustrating situation, it is recognized that variability in *subjective* determinants of severity of frustration was not eliminated. Such subjective variability stems from differences in degree of motivation, a large component of which is associated with individual differences in experiential background and is not accessible to experimental control. This difficulty was also recognized by Sherman and Jost, who pointed out the fact that such motivational differences could not even be accurately measured. While the present investigation does not overcome this source of variation or even pretend to have any method of measuring it, an attempt was made to analyze individual differences in the nature of the effective motivations. The technique of eliciting motivational factors is outlined in the description of method.

The present investigation differs in its theoretical orientation from that of Sherman and Jost insofar as an emphasis is placed upon overt behavior as the more meaningful criterion of frustration reactions. Sherman and Jost's reference to physiological indices as the most sensitive signs of "the point at which frustration occurs" treats frustration in a rather non-specific sense. The fact that these physiological changes are at best indications of some general emotional arousal of almost any character was demonstrated by those neurotic subjects in their study whose frustration reactions could not be clearly determined because of the excessive physiological reactions during the control period—obviously demonstrating the operation of other emotions than those associated with the standard frustration.

Our position is closer to that of Rosenzweig in that the adequacy (adaptiveness) of the behavioral response is held to be the psychologically more meaningful criterion of frustration tolerance. The fact that certain physiological reactions are more accessible to measurement than overt behavior simply imposes a methodological problem, namely, that of devising a means of quantifying the degree of non-adaptive activity at the behavioral level. In the present investigation an effort was made to accomplish this through the use of a multiple behavior-rating scale. The relative absence of non-adaptive behavior is thus the operational criterion of frustration tolerance employed in the present experiment. Using this as a point of departure, the investigation was designed to permit an analysis of the relationship of the behavioral criterion of frustration tolerance with several physiological indices of emotion associated with the frustrating situation.

C. PURPOSE

Since this study was exploratory in nature, the first purpose was to devise a laboratory situation which, on the basis of preliminary observation, could be expected to produce an experience of frustration in pre-adolescent children. The other requirements of this situation, i.e., that it be objectively uniform (same amount of time spent at task, same comments by experimenter, etc.) that it be sustained, plausible, etc., have been mentioned above.

The second step was to investigate the changes both in behavioral and in physiological reactions from control to experimental period to see whether the standard situation produced (*a*) alterations of overt behavior and (*b*) physiological disturbance (i.e., statistically significant differences from experimental to control periods in the averages of the various physiological measures taken).

The third step was to investigate possible relationships between the significant physiological reactions of the individuals and the extent of overt behavior changes (as estimated by a special rating scale) to see whether any physiological excitement occurring in the experimental period might be reasonably interpreted as associated with frustration.

The fourth step was to investigate further the nature of the experience with regard to the motivational factors reported to be operative through a post-experimental interview and questionnaire.

A final aim was to shed light on the possible dynamics of the frustration behavior and also to obtain information on the limitations in applicability of the findings. This was attempted through the examination of correlations between certain "traits" of the subjects and their (physiological and behavioral) frustration-tolerance ratings.

D. METHOD

Two experimenters were required, one to work with the subject and one to operate the recording equipment. The procedure consisted of presenting each subject with a series of two stylus mazes to be run blindfolded. Recordings of pulse rate, galvanic skin response,[3] blood pressure, tremors of the non-dominant resting hand and four respiration measures (as shown in Tables 5 and 6) were made with the Darrow photopolygraph. *EEG* recordings were taken but were not used because they contained excessive movement artifacts. Both experimenters made careful observations which formed the basis of their ratings on the scale shown in Table 3.

The control maze, used to produce an experience of success, was simple, and path blocks[4] were employed to prevent retracing and thereby keep the trial time uniformly short for all subjects. Three trials were given on this easy maze. To give the impression of success, each trial time was made shorter than the immediately preceding one (by experimenter's manipulation of the path-block), and standard comments, consisting of encouragement and praise, were introduced during these success trials.

Following a three-minute rest period, during which the control measures were made, the subject was introduced to the frustration maze. To give the impression that it had a solution, an orientation trial with eyes open was allowed prior to the actual task. After the subject was blindfolded, successful running was made impossible by blocking the true path for the first 10 minutes. In addition, the experience of failure was heightened by a running series of uniformly timed remarks, strongly critical of the subject's performance. After 10 minutes of unsuccessful effort the subject was interrupted and asked to rest before proceeding further. During this three-minute rest period the experimental frustration measures were taken. At the end of that time, the experiment proper was completed but for purposes of reassurance, the subject was allowed to return to the task, which was then altered to insure final success. This was done by removing the path blocks before the goal and using them to prevent retracing. To dissipate the feeling of frustration, the time was made very short and final achievement of the goal was accompanied by strong praise and an interpretation of the extreme difficulty of the task. Samples of experimenter comments are given in Tables 1 and 2.

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[3] The most useful expression of galvanic skin response (for purposes of this investigation) was the summation of per cent ohm changes computed by converting each response defined as a drop in resistance of at least 100 ohms) into its percentage of the general level of resistance existing just prior to the response. *GSR* for each unit interval (30 sec. recording) was expressed as the total of such per cent ohm changes as were recorded in that period.

[4] These were two wooden blocks, which fitted into any part of the maze path, and were fastened to the ends of pencils for ease of manipulation.

After being removed from the apparatus and receiving further reassurance, the subject was interviewed with regard to his motivation by means of the check list in Table 4.

Throughout the procedure, the experimenter who made the comments also made notes of the subject's verbal and expressive behavior. He also recorded the subject's estimates of expected trial times to obtain data for an index of aspiration level.

TABLE 1

OUTLINE OF EXPERIMENTAL SEQUENCE SHOWING STANDARD TRIAL TIMES (CONTROLLED BY EXPERIMENTERS) AND STANDARD REST PERIODS

A. *Preliminary*
   1. *5 min.*—Adaptation and calibration of instruments.
   2. *1 min.*—Preliminary control recordings.

B. *Success Tasks* (Control)
   1. *2 min.*—Maze I—Trial 1.
      (15 sec. interval)
   2. *1½ min.*—Maze I—Trial 2.
      (15 sec. interval)
   3. *1 min.*—Maze I—Trial 3.
   4. *3 min.*—Control Rest Period.

C. *Frustration Task* (Experimental)
   1. *10 min.*—Maze II—Trial 1. (True path blocked).
      (interruption at the end of 10 min.)
   2. *3 min.*—Experimental (Frustration) Rest Period.

D. *Post-Experimental Adjustment*
   1. *½ min. to 1½ min.* (variable)—Continuation of Trial 1 with block removed to permit success.
   2. *1 to 2 min.*—Praise and reassurance following success.
   3. *1 min.*—Post-Experimental recordings.
   4. Further reassurance; motivation questionnaire.

TABLE 2

SAMPLES OF THE STANDARD EXPERIMENTER COMMENTS GIVEN AT SPECIFIED TIMES IN THE ABOVE SEQUENCE

1. *During success tasks*

(First 10 seconds of Trial 1) "You're off to a good start. Keep it up and you'll have that candy bar."

(After completion of Trial 3) "Well, you learned that one in only 3 trials, which is unusually good. Now you can rest a few minutes."

2. *During frustration task*

(End of third minute) "You've been at this some time and you don't seem to be on the right track yet. Keep trying. Remember you got through it when you were looking at it. Mr. ———— (school principal) will be interested in how you do on this. I hope to be able to tell him that you can do as well as the others—or better."

(End of fifth minute) "After the way you did the first maze I thought you'd do a little better on this one. Most boys (girls) of your age don't need much more time than this. You're in a blind alley. Remember, as soon as you get to the end, we'll take all these things off and you can get out of here."

(End of seventh minute) "You're in a blind alley. You seem to be getting stuck a lot. If you just try harder you should be able to get out. I would like to be able to tell Mr. ———— (principal) that you tried hard and made it in fairly good time."

3. *Post-experimental period*

(Immediately after S reaches the goal) "You got it! You've reached the goal. (Pause) This is one of the hardest tests we have in the whole place. We didn't let you know how hard it was when you were working on it. (Pause) we gave this in the Public Schools, and one out of every five . . . didn't get it at all . . ." etc.

E. RESULTS

The findings of this preliminary investigation are based on an intensive analysis of data obtained from 10 children (six boys and four girls) ranging in age from 11 years, 0 months, to 13 years, 10 months. The group was a random sample in this age range of the population of a private institution for normal dependent children (Mooseheart, Illinois).

In order to determine which of the eight physiological measures distinguished between the control condition of success and the experimental condition of failure, a three-fold analysis of variance was performed. The three major sources of variance were: individuals, major three-minute periods (that is, experimental and control resting periods) and half-minute intervals within major periods. The results of this analysis, summarized in Table 5, show that for all measures, the variance due to individual differences was significant at the 1 per cent level. However, the variance associated with frustration (between experimental and control periods) was significant at the 1 per cent level for only the galvanic skin response and pulse rate measures. In the context of the present investigation, these (*GSR* and pulse rate) may then be regarded as the two physiological measures among the

TABLE 3

OUTLINE OF MULTIPLE BEHAVIOR-RATING SCALE[a] USED IN CONJUNCTION WITH FRUSTRATION-TOLERANCE EXPERIMENT

(Basis of overt disturbance scores)[b]

- I. Need-persistive Reactions (S. Rosenzweig)
  - A. Adequate: Adaptive
  - B. Inadequate
    - 1. Social reference: (seeking solution by a method contrary to instructions)
    - 2. Emotional-adjustment reference (insufficient emotional readjustment after final success and reassurance)
    - 3. Non-adjustive activity (A. Zander)
      - *a.* Anxiety
      - *b.* Tension
      - *c.* Nervous habits (W. C. Olson)
        - (1) Oral
        - (2) Nasal
        - (3) Hirsutal
        - (4) Irritational
        - (5) Manual
        - (6) Ocular
        - (7) Aural
        - (8) Genital
        - (9) Facial
- II. Substitute Responses (Attention-getting behavior)
- III. Withdrawing Behavior (A. Zander)
  - A. Active
    - 1. Non-coöperation: quitting or attempting to leave
    - 2. Offering excuses to leave
  - B. Passive.
    - 1. Reduction of effort
- IV. Regression (A. Zander)
  - A. Crying
  - B. Whining, hurt expression

[a] Adapted in part from (*a*) Zander (12) and from concepts described by Rosenzweig (9) and Olson (5).

[b] Those categories into which observed behavior could be classified (on the basis of detailed definitions) were rated on a three-point scale by each of the two experimenters, who later pooled their results and reached agreements as to the final ratings. The overt disturbance score of any subject was the total of these ratings for all items which applied excluding I-A. It was agreed to give a differential rating to Item III-A-1 in the event that the subject withdrew altogether from the situation during the frustration period after initially accepting it, such rating to exceed by one point the highest total rating of any subject on all of the other categories. (Such a reaction did not occur in the present series.)

Because of space limitations the above outline does not include the detailed definitions used in making the ratings. Most of the categories were defined essentially the same as in the sources cited above.

eight obtained whose sensitivity to the frustrating situation was the most dependable. The most sensitive single physiological measure was the galvanic skin response.

Since the *GSR* was the physiological measure in which most subjects showed the greatest change from control to experimental period,

TABLE 4

QUESTIONNAIRE FROM WHICH RANKING OF MOTIVES WAS DERIVED*

Instructions (Girls' form) "Which of the eight girls below felt most like you did on the test you just had?" . . . (instructed to indicate 1st and 2nd choice with "1" and "2" and last with "8")

1. Jane tried very hard even though she didn't seem to be getting anywhere because she felt that she ought to be able to do as well as other girls her age.
2. Marie kept right on trying because she figured she couldn't let Mr. ——— (school principal) or her teacher know that she couldn't make a good record.
3. Louise tried as hard as she could because she wanted to win the candy bar.
4. Doris kept on trying because she was tired of staying in one place with a lot of things attached to her. It looked like the only way to get out in a hurry was to get through the maze. Doris wanted to get out more than anything else.
5. Phyllis decided after a while that it wasn't worth trying because it wasn't a regular test and she knew they would have to let her out sooner or later even if she didn't get through.
6. Frances tried very hard because she didn't want the people who were watching her to think she couldn't finish something once she started it. Frances was most interested in what the people who were watching her would think.
7. Alice kept trying as hard as she could for a reason different from any of the others.
8. Elaine didn't mind being in the room and was in no hurry to get through and didn't care what anyone thought about how she did on the test, so she didn't try very hard.

*This questionnaire utilizes the technique of offering concrete alternative identifications originated by Carl Rogers in his Test of Personality Adjustment, a method well adapted for use with children.

TABLE 5

SIGNIFICANCE OF PHYSIOLOGICAL REACTIONS AS INDICATED BY ANALYSIS OF VARIANCE

	Inter-condition (cont. vs. exp.) levels			Inter-subject levels			Intra-condition (bet. six ½-min. int.) levels		
Measure	Not sig.	.05	.01	Not sig.	.05	.01	Not sig.	.05	.01
Pulse rate			X			X		X	
Blood-Pressure	X					X	X		
Respiration Frequency	X					X	X		
Respiration Amplitude (Mean)	X					X	X		
Variability Respiration Amplitude (σ)	X					X		X	
Suspension of respiration		X				X	X		
No. of hand tremors		X				X	X		
GSR (per cent Ohm change)			X			X		X	

it seemed important to determine whether such increased reactivity was attributable to the frustrating situation as distinguished from some temporally determined variable such as fatigue. First, it may be recalled that both periods during which measures were taken (control and experimental) were rest periods of equal length following periods of activity but that the frustration period occurred later in the experiment. To determine whether a temporal factor was responsible for the changes, *GSR* measures taken still later in the session, but after frustration had been relieved (post-experimental adjustment period), were compared with those taken in the control and in the frustration periods. Eight of the 10 subjects had shown definite gains from control to experimental periods. All of those eight subjects showed complete or partial recovery (return to the control level) in *GSR* during the final post-experimental adjustment period. This finding emphasizes the nature of the experimental period (frustration) rather than its temporal order (or amount of accumulated fatigue) as the factor responsible for the observed changes.

To determine the relationship between these physiological responses and observable behavior reactions under frustration, product moment correlations were computed for each of the physiological measures with the totals obtained on a multiple item behavior rating scale (outlined in Table 3). As Table 6 shows, again only the galvanic skin response and the pulse rate measures correlated significantly with the ratings: .69 and .83 respectively. Greater physiological change was associated with higher over disturbance ratings.

Since the behavior ratings correlated highly with the two most sensitive

TABLE 6

CORRELATIONS BETWEEN OVERT BEHAVIOR AND PHYSIOLOGICAL INDICES OF DISTURBANCE DURING FRUSTRATION

(The value of each physiological index used in computing these correlations is based on a ratio of change arrived at for each subject: (mean value during frustration—mean value during control period)/(mean value during control period). The overt disturbance scores are totals based on the multiple behavior rating scale.)

r's: Overt disturbance scores with:		
(1)	Pulse rate increase	.83*
(2)	*GSR* (Sum of response in per cent ohm change)	.69*
(3)	Blood pressure response increase	.26
(4)	Number of hand tremors	.13
(5)	Respiration rate	.29
(6)	Respiration amplitude	.00
(7)	*Variability of respiration amplitude*	—.05
(8)	Respiration suspension	—.05

*Statistically significant.

physiological measures, as determined by the analysis of variance, these ratings of behavioral disturbance have been tentatively selected as a convenient criterion of frustration tolerance.

F. SUPPLEMENTARY FINDINGS

As an approach to the question of what general significance these findings may have, the behavior ratings, converted into a frustration tolerance index, were correlated with other variables. A physiological frustration-tolerance index based on the *GSR* was similarly correlated. The results, presented in Table 7, show that mental age and *IQ* both correlate positively with frustration tolerance according to both indices, suggesting that brighter children have a higher degree of tolerance for this kind of frustrating situation, perhaps because it is less threatening to them. Correlation of the behavioral *FT* index with a general social status aspiration level, determined from a questionnaire, was negative, suggesting that individuals with a high aspiration level with reference to group status tend to react to frustration more severely, perhaps because they are under more internal pressure to succeed. The correlation of the physiological (*GSR*) *FT* index with a measure of

TABLE 7
CORRELATION BETWEEN FRUSTRATION TOLERANCE INDICES AND OTHER VARIABLES
(The starred correlations are statistically significant)

	Variables	Behavioral *FT* Index[a] (based on overt disturbance scores)	Physiological *FT* Index[b] (based on *GSR*)
(1)	Chronological Age	—.30	—.09
(2)	Mental Age	.58*	.81*
(3)	*IQ*	.67*	.75*
(4)	Social-status Aspiration Level (based on a questionnaire)	—.60*	—.47
(5)	Experimental Aspiration Level[c]	—.43	—.63*
(6)	Talkativeness in Classroom[d]	—.55*	—.48
(7)	Educational Retardation[e]	—.48	—.43

[a] Behavioral Frustration Tolerance Index = 15 — (sum of overt disturbance scores). This conversion causes tolerance rating to vary inversely with the amount of observed disturbance.

[b] Physiological Frustration Tolerance Index =

$$80 - \left[10 \, \frac{\text{Av. Exp. } GSR - \text{Av. Cont. } GSR}{\text{Av. Cont. } GSR} \right]$$

[c] Based on subject's estimates of last two trial times on control maze subtracted from his actual time on each of the respective preceding trials (av. of the two differences).

[d] Based on a classroom observation study conducted by Mary Alice Hansen over an eight-month period on 100 children at Mooseheart including those in the present study.

[e] Educational Retardation = (*CA* — *EA*) on Stanford Achievement Test.

aspiration level in the specific experimental situation showed the same tendency. Talkativeness in classroom correlated significantly and negatively with the behavioral frustration tolerance rating, which suggests that classroom talkativeness represents a violation of classroom restraints by those least tolerant of frustration and therefore least able to conform to such restraints.

To investigate the possibility of a relationship between behavior ratings of frustration tolerance and estimates of gross personality adjustment, a clinician, without knowledge of the experimental findings, made personality adjustment ratings on the basis of clinical records which included test findings, clinic staff evaluations, administrative reports, and faculty evaluations. The two types of ratings did not correspond significantly. The clinician who rated the case record material for general adjustment found some inconsistencies among evaluations from different sources (that is, school, clinic staff, supervisors, etc.). It was felt that these diverse sources of information made it difficult to obtain a unitary impression of total adjustment. Also, in view of the correlations between frustration tolerance and such factors as *IQ*, aspiration level, and classroom talkativeness, it was suspected that adjustment seen in the more uniform environment of the school situation, might have a more direct bearing upon the kind of frustration tolerance elicited in this experiment. This supposition was further strengthened by the introspective material pertaining to motivational factors presented in Table 8. The need to preserve status with school personnel was decidedly more predominant than any of the other motives.

It was therefore decided to determine whether frustration tolerance, as derived from ratings of behavior during the experiment, might be related

TABLE 8

RANK ORDER OF IMPORTANCE OF MOTIVES AS GIVEN BY SUBJECTS
(Abbreviated Description—parenthetical numbers refer to item numbers in questionnaire in Table 4)

Rank	Motive	Frequency of selection (1st choice)	Frequency of selection (2nd choice)
1	Preserve status with school personnel (2)	4	4
2	Preserve ego-level with reference to own age group (1)	3	0
3	Preserve status with experimenters (6)	1	3
4	Escape from discomfort and confinement of experimental situation (4)*	2	1
5	Tangible reward (candy bar) (3)	0	1
6	Urge to complete an attempted task (as specified by *S*) (7)	0	1

*Motive No. 4 is the only differentiating one, selected three times by *S*'s in the least tolerant half of the group and not at all by the most tolerant half.

to adjustment in the school situation by comparing the experimental behavior ratings with independent ratings for school adjustment. Descriptions of school behavior and adjustment of each of the 10 subjects, abstracted from teachers' reports, were rated independently on a three-category basis by each of three judges. The descriptions were coded to preclude identification of the subjects by the judges. Combining the ratings of the three judges it was found that the estimates of school adjustment were significantly related to the frustration tolerance ratings (Chi square significant at .01 level). The tendency was for those with low tolerance to make poor adjustments in school and for those with high tolerance to make either good or fair school adjustments.

G. DISCUSSION

The above relationships suggest that the ratings derived from this experimental technique provided estimates of a kind of frustration tolerance which was characteristic of the subjects within a limited frame of reference (school). The usefulness of these tolerance measures depends upon recognition or identification of the frame of reference in which they apply and upon limiting interpretations to this frame of reference. A systematic method of eliciting introspective data regarding motivation helps to identify the relevant frame of reference, but the experimental set-up does much to determine the particular frame of reference.

The method utilized in this investigation provides certain information about personality dynamics when the motivational aspects of the situation are taken into account, and when the frame of reference within which the measures apply is known. It is evident from Table 8 that the motivation of most of the subjects involved preserving status with individuals in authority, particularly the school personnel; in addition, the various correlations were focussed on the school situation as the relevant frame of reference. From a practical standpoint, the present method may yield important information as to how seriously a child may be expected to be disturbed emotionally by failure or the threat of failure in the area of school achievement. Individual differences in reaction to frustration in other areas might be investigated by an experimental procedure which is organized around a different set or places the frustration in a different frame of reference.

As a note of caution, the method described is not recommended for use with very disturbed children without substantial modification because of the possibility of traumatizing effects, particularly from the more disparaging comments.

H. Conclusions

Although these results of a laboratory study of frustration tolerance are based on a relatively small series of subjects intensively analyzed, the findings here reported demonstrate the usefulness of the method described and provide an estimate of the validity and general applicability of certain experimental measures of frustration tolerance. The most discriminating physiological criteria are the galvanic skin response differences from control to experimental period and similar pulse rate increases. Further, the findings suggest that a criterion of frustration tolerance based on a multiple behavior rating scale is more readily obtained and as meaningful as any index derived from one or more physiological measures. Such ratings have a significance beyond the experimental situation from which they were derived when interpreted in the light of the motivational aspects of the situation. Specifically there is evidence that the subject is motivated with regard to a particular frame of reference determined largely by the instructions on the task and the kinds of comments used. It is only within the relevant frame of reference that the experimentally derived estimates of frustration tolerance apply.

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ACHIEVEMENT OF A GROUP OF CHILDREN IN FOSTER HOMES AS REVEALED BY THE STANFORD ACHIEVEMENT TEST*

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A. Introduction

The personality of the individual is affected by the amount and quality of love and affection he receives. An important additional factor affecting the emotional growth of the individual is his ability to secure recognition for his achievements, achievements which approximate the level of his ability. That the lack of quality of love the individual receives may affect the quality of his production, either in getting along with people, becoming adjusted in society, or in performing on the level of his innate ability has already been noted (11). Social workers have recognized the possible traumatic factor of children placed away from their own home, and have therefore made available to them professional care to counteract the trauma.

The present study concerns itself with 100 children examined on the Stanford Achievement Test (9, 10) while they were residing in foster homes. This represents the total population of the children in foster care examined by me during this period. Fifty were males and 50 were females. They were under the care of the Children's Department of the Jewish Social Service Bureau of Detroit which has been in operation either as an autonomous organization or as part of the Bureau since 1901 (6). The mean age of this group was 12 years, the range being 9 to 16 years inclusive. The mean *IQ* was 104.9, the range being 75 to 192 inclusive.

This study is a part of a larger study in which the performance of four groups of children are being studied. The study of a group of maladjusted boys in a home for delinquents appeared in another journal (4). The studies of children in orphan homes and in their natural home will appear later. A comparison of the results obtained by the foster home child will be made with those obtained by the maladjusted group.

There were the following differences between the populations studied, the

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boy of Boys' Republic being on the average two years, three months older and their *IQ*'s some 19 units lower. Besides the factor of sex, there was also the factor of previous cultural environment, since the children in the Boys' Republic were, with the exception of one case, non-Jewish, and all of the children studied in the Foster Care group were Jewish. The children in foster care came from homes of higher cultural level, a level approximately normal. In addition, all of the boys at the Boys' Republic were placed by order of the Court and hence, placement was in no case voluntary, while the incident of placement of the foster care children in many cases was on a voluntary basis and in many instances, also, the placement was accomplished after a social worker had secured the coöperation of the child favoring the acceptance of placement. Another factor of difference was that the boys of the Boys' Republic were placed because of some act originating in themselves, while the placement of children in the foster homes was because of some conditions over which they had little or no control, namely the activity of their parents. The factor of guilt concerning the placement should, therefore, appear more likely in the former situation than in the latter. This in no way relieves the parents of their responsibility for the difficulty in which the boys in Boys' Republic found themselves. On the other hand, there were also instances among the children under foster care in which the child was a disturbing factor in the family situation, a situation which lead to the request for placement.

B. STATISTICAL DATA

A record was kept of the grade (G) in which the child was placed at the time of the examination and the grade scores or grade achieved on each of the items of the Stanford Achievement Test, e.g., Paragraph Meaning (PM), Word Meaning (WM), Reading (R), which is a mean score obtained from PM and WM, Language Usage (LU), Arithmetic Reasoning (AR), Arithmetic Computation (AC), Arithmetic (A), which is a mean score obtained from AR and AC, Literature (L), Social Studies I (SSI) which is loaded with questions concerning history, Social Studies II (SSII) which is loaded with questions concerning geography, Social Studies (SS) which is a mean score between SSI and SSII, Elementary Science (ES), Spelling (S), and Total (T).[2] The mean, standard deviation of the mean, standard error of the mean, intercorrelations among the tests, differences between the means, the standard error of the difference, and critical ratios were calculated. Some comparison between the data obtained in this study and those obtained among the maladjusted group of boys were noted.

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[2] The initials are used exclusively in the tables presented.

TABLE 1
MEAN ACHIEVEMENT, BY GRADES, OBTAINED BY THE 100 FOSTER CARE CHILDREN, COMPARED WITH PERFORMANCE OF THE SOCIALLY MALADJUSTED GROUP ON THE STANFORD ACHIEVEMENT TEST

Subject	Maladjusted Group (4)			Foster Care Group			Acceleration of Foster Care over Maladjusted	D/σ_D
	Mean	*SD*	*M*	Mean	*SD*	*M*		
P.M.	5.8	1.9	.06	6.2	1.7	.17	.4	2.20
W.M.	6.4	2.0	.07	6.8	2.0	.20	.4	1.43
R	6.1	1.8	.06	6.5	1.8	.18	.4	2.11
LU	5.4	2.0	.07	6.2	2.1	.21	.8	3.33
AR	5.9	1.4	.05	5.9	1.6	.16	.0	0.00
AC	5.3	1.6	.05	5.7	1.5	.15	.4	2.50
A	5.6	1.5	.05	5.8	1.5	.15	.2	1.25
LI	5.9	2.4	.08	6.8	2.3	.23	.9	3.75
SSI	5.8	2.3	.08	6.4	2.7	.27	.6	2.14
SSII	6.0	2.1	.07	6.4	2.0	.20	.4	1.90
SS	5.9	2.1	.07	6.4	2.3	.23	.5	2.08
ES	5.9	2.4	.08	6.1	2.2	.22	.2	.87
S	5.7	1.9	.06	6.5	2.0	.20	.8	3.63
T	5.7	1.7	.06	6.2	1.7	.17	.5	2.78
G	7.7	1.2	.04	7.1	1.5	.15	—.6	3.75

The mean achievement of the foster home children compared with that obtained from the maladjusted group is revealed in Table 1. Although the average foster home child was 2.3 years younger than the average child in the maladjusted group, the child in foster care was only six-tenths of a grade on the average below that of maladjusted group and accelerated in achievement from 0 to .9 grade, the lowest difference being in arithmetical reasoning, which was 0, and the greatest difference in literature. Comparing their actual grade placement with what they achieved, the foster care children were retarded from .3 to 1.4 school years in their actual achievement, while the maladjusted group of boys revealed a retardation from 1.5 to 2.37 years. Significant differences between the means of the two groups were found in Literature, Language, Spelling, and in actual grade placement, while there was a tendency toward significance in arithmetic computation and general results. The boys of the Boys' Republic performed best in tests requiring multiple choice. Tests which required exactitude in thinking were the tests in which they performed poorly. The foster home children also excelled in tests of multiple choice, but spelling, which is not a multiple choice test, was a subject in which they did relatively very well.

A comparison of rank order of performance is made of the performance of the foster care children with the maladjusted boys both of the group studied previously and reported in this JOURNAL and another group of mal-

TABLE 2

Vera Chase	Feinberg's Maladjusted	Feinberg's Foster Care
Paragraph Meaning	Word Meaning	Word Meaning
Word Meaning	Geography	Literature
Geography	History and Civics	Spelling
History and Civics	Literature	Geography
Literature	Elementary Science	History and Civics
Language Usage	Arithmetic Reasoning	Language Usage
Spelling	Paragraph Meaning	Paragraph Meaning
Arithmetic Reasoning	Spelling	Elementary Science
Elementary Science	Language Usage	Arithmetic Reasoning
Arithmetic Computation	Arithmetic Computation	Arithmetic Computation

adjusted (165) boys studied by Vera Chase (2). It appears that subjects requiring greater mental discipline appear at the lower end of the scale in the foster care group of children.

When compared with other foster home groups, the group in this study did not perform as well as might be expected. Four hundred and one children of the Illinois Children's Home and Aid Society who were placed at least five years in foster homes, tended to show a better school placement situation in that 69 per cent of the 348 of this group, or those of school age, were in normal grades for their age, while 11 per cent were accelerated and 20 per cent were retarded according to their age. Limiting the study to children whose entire life was in an improved environment, 75 per cent were normally placed, 15 per cent were accelerated, and 11 per cent were retarded. "In fact those foster home children made better progress in school than the Gary Survey of 1918 indicated" (5). "It made little difference whether it was in Chicago, small towns or rural communities, they made more than normal progress in school," according to a report of the New York Board of Education (5).

Each subject was correlated with each other and with results and grade allocations.

High correlations exist among paragraph meaning, word meaning, and reading. The arithmetical items correlate highly among themselves. Social Studies I, Social Studies II, and Social Studies correlate highly with each other. This was due to the fact that the reading score, arithmetic score, and social studies score make up the total for the tests in the respective groups. For the same reason the total score correlates highly with all the subtests. In general, there are substantially high correlations among all the tests and with grade placement, with the lower correlations found between paragraph meaning and grade placement, language in its relationship to arithmetic reasoning, arithmetic computation, Social Studies I and grade

TABLE 3

Interest Correlations-East Test With Every Other Test, With Total and Grade Placement on the Basis of Grade Level Achieved by the Foster Care Children on the Stanford Achievement Test

		PM	WM	R	LU	AR	AC	A	L	SSI	SSII	SS	ES	S	T
WM	*r*	.770													
	PE	.027													
R	*r*	.972	.962												
	PE	.004	.005												
LU	*r*	.709	.758	.790											
	PE	.034	.039	.025											
AR	*r*	.700	.689	.704	.451										
	PE	.034	.035	.034	.054										
AC	*r*	.639	.616	.626	.564	.782									
	PE	.040	.042	.041	.046	.026									
A	*r*	.693	.680	.708	.591	.927	.943								
	PE	.035	.036	.034	.044	.009	.007								
L	*r*	.672	.694	.696	.632	.623	.614	.657							
	PE	.037	.035	.035	.041	.041	.042	.038							
SSI	*r*	.689	.821	.715	.595	.700	.632	.706	.707						
	PE	.035	.022	.033	.044	.034	.041	.034	.034						
SSII	*r*	.675	.732	.682	.626	.666	.570	.650	.761	.806					
	PE	.037	.031	.036	.041	.038	.046	.039	.028	.024					
SS	*r*	.707	.733	.749	.636	.766	.644	.650	.752	.963	.931				
	PE	.034	.031	.030	.040	.028	.039	.039	.029	.005	.009				
ES	*r*	.718	.778	.790	.674	.704	.647	.720	.679	.681	.670	.877			
	PE	.034	.027	.025	.037	.034	.039	.032	.036	.036	.037	.016			
S	*r*	.785	.855	.881	.686	.679	.599	.646	.671	.622	.609	.609	.700		
	PE	.026	.018	.015	.036	.036	.043	.039	.037	.041	.042	.042	.034		
T	*r*	.870	.878	.942	.809	.827	.766	.838	.813	.849	.849	.871	.876	.850	
	PE	.016	.015	.008	.023	.021	.028	.020	.023	.019	.019	.016	.016	.019	
G	*r*	.562	.651	.625	.504	.646	.616	.667	.630	.624	.552	.635	.610	.735	.747
	PE	.046	.039	.041	.050	.039	.042	.037	.041	.041	.047	.040	.042	.031	.030

TABLE 4

DIFFERENCE BETWEEN THE MEAN GRADE ACHIEVED BY THE FOSTER CARE CHILDREN AMONG THE ITEMS TESTED BY THE STANFORD ACHIEVEMENT TEST AND THEIR ACTUAL GRADE PLACEMENT

		PM	WM	R	LU	AR	AC	A	L	SSI	SSII	SS	ES	S	T
WM	$M_1 - M_2$	.61													
	σ_D	.126													
	CR	4.841													
R	$M_1 - M_2$	.31	.30												
	σ_D	.036	.173												
	CR	8.611	1.673												
LU	$M_1 - M_2$	.01	.60	.30											
	σ_D	.022	.142	.130											
	CR	2.244	4.225	2.308											
AR	$M_1 - M_2$	.32	.93	.63	.33										
	σ_D	2.126	.143	.129	.199										
	CR	2.540	6.503	4.883	1.658										
AC	$M_1 - M_2$	.51	1.12	.82	.52	.19									
	σ_D	.166	.157	.143	.177	.103									
	CR	3.072	7.134	5.734	2.938	1.845									
A	$M_1 - M_2$	.40	1.01	.71	.41	.08	.11								
	σ_D	.124	.144	.126	.172	.059	.160								
	CR	3.226	7.014	5.635	2.384	1.356	.688								
L	$M_1 - M_2$	.57	.04	.26	.56	.89	1.08	.91							
	σ_D	.169	.168	.130	.188	.193	.180	.171							
	CR	3.373	.238	2.000	2.979	4.611	6.000	5.673							
SSI	$M_1 - M_2$	.23	.38	.08	.22	.55	.74	.63	.34						
	σ_D	.197	.157	.190	.223	.190	.211	.197	.195						
	CR	1.168	2.382	.421	9.685	2.806	3.507	3.198	1.744						

TABLE 4 (*continued*)

		PM	WM	R	LU	AR	AC	A	L	SSI	SSII	SS	ES	S	T
SSII	$M_1 - M_2$	.20	.41	.11	.19	.52	.71	.60	.37	.03					
	σ_D	.151	.145	.216	.178	.151	.169	.153	.150	.161					
	CR	1.325	2.828	.509	1.068	3.444	4.201	3.922	2.467	.186					
SS	$M_1 - M_2$	.23	.38	.08	.22	.55	.74	.63	.34	.00	.03				
	σ_D	.125	.157	.150	.187	.147	.173	.172	.158	.256	.083				
	CR	1.840	2.382	.533	1.176	3.547	4.278	3.663	2.152	.000	.361				
ES	$M_1 - M_2$	.10	.71	.41	.11	.22	.41	.30	.67	.33	.30	.33			
	σ_D	.153	.142	.137	.176	.159	.210	.156	.181	.202	.174	.112			
	CR	.654	5.000	2.993	.625	1.384	1.953	1.923	3.702	1.634	1.897	2.946			
S	$M_1 - M_2$	.29	.32	.02	.28	.61	.80	.69	.28	.06	.09	.06	.39		
	σ_D	.125	.107	.095	.164	.149	.164	.155	.175	.214	.177	.121	.242		
	CR	2.320	2.991	.211	1.707	4.094	4.878	4.452	1.600	2.803	.508	.496	1.611		
T	$M_1 - M_2$	.03	.58	.28	.02	.35	.54	.43	.54	.20	.17	.20	.13	.26	
	σ_D	.087	.093	.060	.126	.098	.110	.089	.132	.155	.047	.114	.111	.106	
	CR	3.345	6.237	4.667	.159	3.571	4.909	4.831	4.091	1.290	3.617	1.754	1.171	2.453	
G	$M_1 - M_2$	.90	.29	.59	.89	1.22	1.41	1.30	.33	.67	.70	.67	1.00	.61	.87
	σ_D	.150	.151	.157	.188	.131	.133	.121	.177	.213	.172	.175	.178	.136	.117
	CR	6.000	1.921	3.758	4.734	9.313	10.602	10.744	1.864	3.146	4.070	3.829	5.618	4.485	7.179

placement, arithmetic computation in its relationship with Social Studies II and spelling, and Social Studies II in relationship to grade placement. The lowest of these was .45 between language and arithmetic reasoning. Word meaning and spelling, reading and spelling, and elementary science and social studies correlate very highly. There is a difference in the configuration of the correlations between the foster home children and the maladjusted group in that (*a*) arithmetic correlates with other subjects for the former group consistently well, and (*b*) language also correlates well with other subjects. Language and arithmetic, however, show relatively similar correlations with each other in both groups. Also, there appears to be better agreement between grade allocation and the achievement scores among the foster home children than among the maladjusted group.

The differences between the means and the reliability of the findings are found in Table 4. The greatest difference between the means occur between word meaning and arithmetic computation (1.12 years), arithmetic computation and literature (1.08 years), grade placement and arithmetic reasoning (1.22 years), grade placement and arithmetic computation (1.41 years), grade placement and elementary science (1.00 year). Literature and word meaning reveal the smallest difference between grade placement and the achievement in these subjects.

C. Comments

Florence Goodenough (7), in her study of 100 children of the Minneapolis Child Guidance Clinic, revealed that the reading level was one-half year behind grade placement. The chronological age and grade placement was in better agreement with each other than grade placement and mental age or reading ability, or any of the measures of ability considered. Others have likewise noted a better agreement existing between grade placement and chronological age than grade placement and any other factor (3). The foster care children have a mean age of 12 years and are on the average in the 7.1 grade, which is a normal situation. Since the achievement is on the 6.2 grade basis, they appear to be retarded on the average of one year. Hence, here too, chronological age must be factor in grade placement, exceeding all other factors for proper grade placement.

There is in effect little difference in the situation between children living at home, who are rejected or overprotected, than in the situation where there is a broken home. The absence of the quality of love and affection, as well as the amount of love and affection, is common to both situations. That this develops feelings of insecurity has been noted repeatedly in the literature (11).

The situation of absence of love and affection, however, may not be without its compensations. Unlike the situation in which the children of the maladjusted group found themselves, the foster care children appear to have greater incentive and their motivation places them scholastically on a higher level than the children of the former group. Failing to secure recognition in the home, failing to secure the quality of love and affection, these children must secure their satisfactions from other sources. The cultural environment being of a higher level than those in homes of the maladjusted, the type of satisfactions sought are on a more socially acceptable level. They must succeed in the group, since the family is not a factor upon which they may depend. Hence, there is a striving to make good grades. Mildred Bergum, in a study of 25 known rejected children, found that 100 per cent of them tended to be independent, 15 were capable of amusing themselves, 10 made good adjustments outside of the home, five were responsible, eight readily responded to affective relationships, and 10 revealed evidence of early maturity (1).

The foster care child, however, is in a less protected environment than is the maladjusted child in an institution, or very probably the child in the orphanage. He is in an environment that is more permissive than in either of the other two groups, though very probably less permissive than are his friends who live in their natural homes. Despite the fact that he is motivated to succeed, he is disturbed by the differences between what other normally placed children secure in love and affection and what he receives. This is true no matter how good the foster home may be. The normal quality of love and affection just is not to be had.

The foster care child, hence, seems to have a better facility in the verbal situation than does the maladjusted institutional child. His spelling is on a higher level. But in items which require good organization in thinking, such as arithmetic computation, arithmetic reasoning, paragraph meaning, language (grammar), and elementary science, he cannot accomplish his task as well as should normally be expected. The disturbing factors tend to reveal themselves here as they do in the maladjusted institutional group to interfere with good mental discipline (8).

D. SUMMARY

1. On the whole and in each item studied, this group of children have not been placed in grades on the basis of scholastic achievement.

2. With the exception of arithmetic reasoning the foster home children achieve on a higher level in all subjects when compared with the institu-

tionalized maladjusted despite the fact that the foster home child is younger. The factor of higher *IQ* among the foster home group may be significant in producing this result. On the other hand, the foster care children appear to be motivated to succeed in a socially acceptable sphere of activity and gain recognition here in lieu of the lack of recognition on the basis of normal love and affection.

3. Positive correlations exist among all of the academic items test, but there appears to be significant differences between paragraph meaning and word meaning, paragraph meaning and reading, reading and language, word meaning and elementary science, language and geography, arithmetic reasoning and word meaning, arithmetic reasoning and reading, arithmetic computation and paragraph meaning, word meaning, reading, literature, geography, social studies, and spelling, arithmetic and paragraph meaning, word meaning, reading, literature, history, geography, social studies, and spelling, arithmetic and literature, history, geography, social studies and spelling, literature and elementary science, history and elementary science, geography, social studies, and spelling. This suggests that foster care children tend to accomplish better in subjects requiring lesser amount of mental integration.

4. The general pattern of performance is that of disturbed children, the reading level being consistently higher than arithmetical items (8).

5. The performance of children lacking normal quality and amount of love and affection can be detected on the achievement test by noting the pattern of a child's performance. Since the school receives children at an early age, the teacher may be at an advantage point to note the possibility of such disturbing factors from the performance of children on the achievement tests.

6. This study, again, points to a possible necessity of re-organizing the curriculum of the public school so that they may deal with atypical performances of children.

7. The factor of *IQ* does not interfere with the pattern of performance of disturbed children. We noted that the children of the maladjusted institutional group had on the average dull or low average intelligence, whereas the children of the foster care group were normal.

8. If the intake of the Children's Department continues as in the past, the present pattern as described herein will continue.

9. The importance of helping these foster care children to succeed on the level with their general ability lies in the fact that such accomplishment may prevent severe emotional conditions due to the lack of quality of love and affection.

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The Journal of Genetic Psychology, 1949, **75**, 305-320.

BOOKS

The *Journal of Genetic Psychology,* the *Journal of General Psychology,* and the *Journal of Social Psychology,* will buy competent reviews at not less than $2 per printed page and not more than $3 per printed page, but not more than $15.00 for a single review.

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The Journal of Genetic Psychology, 1949, 76, 307-312.

(Alschuler, R. H., Hattwick, L. W. Painting and Personality. (2 vols.) Chicago: Univ. Chicago Press, 1947. Pp. 590.)

Reviewed by Dorothy Tilden Spoerl

Painting and Personality is a careful and conscientious study of the relationship between a child's creative work with brush and paper and that child's personality. Its thorough documentation, in spite of its criticized lack of "high critical ratios," will make it a source book for research, a reference book for interpretation, and a starting point for creative thinking about children for many years to come.

The idea that the personality of children shows clearly through their creative products is not a new one. Many have seen the degree to which understanding of the child can come through understanding of his creative work; not the content of pictures alone but through line and form, space and color. Yet many who have recognized this basic relationship have not had, or taken, the opportunity of so detailed a study of the structure of the activity.

Daily observation of 149 children throughout an entire school year is a difficult task, case histories of the same children cannot be written without time and thought, and the analysis of the artistic products created by the children during that space of time presents a task of which one can scarcely dream the proportions.

Volume I presents the general interpretations which came as a result of the research, Volume II the individual biographical summaries of each child, and the statistical presentation of the material. In this mass of material one fact does bother the present reviewer. Unless she has overlooked it in the mass of detail presented there seems to be no specific statement made as to the amount of easel painting done by the children as a whole, or any one child in particular. How many paintings is a "large output," how many a small, and were there no children whose interest was so lacking that they participated to the extent of only one or two paintings, or even of no paintings at all? If there were such children what is the meaning of their unwillingness?

For those who want material to be direct, in the form of rules which can be abstracted from a book and applied to a specific painting this study will be entirely unsatisfactory. But perhaps such people should not be allowed to study or interpret the life of the little child, for very wisely these authors have maintained that their material cannot be "indiscriminately applied to individual cases" (page 4), because "in the analysis and interpretation of a given painting it is more often in the interrelationships of several aspects than in any single characteristic that the distinctive and telling qualities of the child's products are likely to lie." How many of us who have been interested, though not always adept, in the analytical interpretation of paintings, or finger paint, of play, or or dreams, have been bedevilled by the parent or friend, student or stranger, who has suddenly appeared on our doorstep with a single product demanding to know, "What does *this* mean?" Any technique which attempts to interpret the myriad aspects of a single personality must take far more into account than the single product, and most particularly when the single product is influenced as much by the unconscious as the conscious aspects of that personality. If Alschuler and Hattwick have done no more than to convince persons interested in painting and personality of this single fact they have done something of inestimable service to psychology in general, and the psychology of the creative process in particular.

More people, perhaps, are willing to admit that the adult personality contains many things which can be traced to unconscious sources; the writer has found students at any rate far less willing to accept an unconscious element in the lives of children. Perhaps we may not be willing to go the whole distance with the authors in their statements from different portions of the book, but at least we should stop to ponder them and try to recognize their deep significance.

> "Apparently, just as creative activity itself springs from some unexplained universal tendency, so the expression of certain universal experiences frequently takes on comparable form. . . .
>
> ". . . In their usage of color, line, form, and space, these children expressed, on the one hand, their individualized, highly subjective experiences, and, on the other hand, in these same paintings their responses were in many respects so basically similar as to suggest that their origin, to some extent at least, lay deep in the history of the human race and in the constitution of the human organism" (p. 4).
>
> "The inner life of young children, the dream life of man, and the ideational life of primitive man apparently all draw directly from the stream of life that comes down through the ages and is transmitted with the germ of life from generation to generation" (p. 74).

Objections or no it seems quite impossible to explain the symbolism of color and form and line in any other way. We must cease our rather rigid thinking that only what can be *proved now* is scientific, and remember that what cannot be disproved may some day show itself as truth. Certainly no one has ever taught children of nursery age that they should use color differentially in relation to emotion. Surely no one has urged curves rather than straight lines, the using of whole or fractional pages or going beyond the limits of the page! And psychology has recognized for a number of years the truth of this idea that children can and do express in artistic creation of many types ideas, emotions, and thoughts which they are completely incapable of expressing through the medium of verbalization. It was not by accident that Rouma in 1913 entitled his monumental study of children's drawings, *"Le Langage Graphique de l'Enfant."*

Before turning to the generalized findings of the study one does raise questions as to why so much emphasis upon easel painting, and finds the answer under *Aims and Methods* which curiously are not presented until one comes to page 169 of the first volume. Five media are used in the study: easel paints, crayons, clay, blocks, and dramatic play. Footnotes in Volume II make clear that much of the material relative to other activities than those at the easel are to be presented later. Finger painting, which seems at first a curious omission, they explain is excluded because of the amount of adult supervision necessary, the social stimulation which results if it is done in a group, and especially the fact that many patterns may appear in the course of the work which are then erased and replaced leaving for the finished product none of the intermediate stages which preceded it. A just enough reason, and yet one wonders if comparison of finger painting in its finished form with easel paintings might not have offered evidence for the basic truth of many of the generalizations?

The authors point out that in the schools they used easel painting as a solitary activity, and one wonders if this fact determines the personality characteristics which emerged when children with a major interest in easel painting are compared with children with a lesser interest. Is it the interest in painting, or the lack of interest in something else which turns them toward the easel? However they further state that easel paintings seem to reveal more of the child's personality than other media which are commonly used in a group setting. Again one wonders if this is related to the fact of the solitary nature of the activity, or if it is related to the fact that at an age when the child has control of his large muscles any activity involving them brings him nearer to the object of creation than something involving a studied effort to use smaller muscles as in crayon work. One factor in finger painting is that no artificial medium is intervening between the child and his product.

Certainly no one can criticize the knowledge which has been secured concerning each child. Perhaps the chief criticism to be made of the study is that there is so much detail that it is sometimes difficult to trace the source or the implications of any of the findings.

One cannot in a review present the wealth of general conclusions. Our special interest is the suggestion that these things are clues to understanding the personality of the child. That they are not statistically significant is really unimportant as long as we remember that they are only hypotheses, and look then to other aspects of the child's life before acting upon them. Choice of color has been shown time and time again to be meaningful in human personality, yet it is important to find that this differential use of color stems from so early a period as the preschool years. Nor do the authors say that color must always have a single meaning, for instance we find them speaking of red as it may be used to express affection, and also as it may be used to express hostility or aggression. The use of blue in the case of children tending toward controlled behavior is of interest. So too the happiness of children consistently using yellow, or the use of green by children who show a lack of strong, overtly expressed emotion. One does not take these facts and arrange for himself a neat little package to be entitled, "the language of color"; but one can look to the painting and the personality and through the interpretation of the color sometimes come to a better understanding of both.

Of greater interest seems to be the findings in regard to colors that overlay other colors, or the use of colors in parallel in a single painting. The theory that the colors used for overlay express the overt level of personality, the underlying colors the less expressed areas offers many fruitful suggestions both for interpretation and for further research.

Perhaps those who are tempted to a too specific application of the findings in regard to color should copy down the author's warning on page 50 and pin it where they can see it often:

> Our examination of color has shown how color choice may reveal much about the individual's emotional make-up. But colors, in themselves, do not indicate in what direction or within what limits the emotional drives are operating. . . . In every individual case, as we have tried to demonstrate, the given generalization can be validated, negated, or modified only after due consideration of all aspects of the individual child's painting and the dynamics of his personality.

It is not our purpose to review the specific findings in relation to color, line and form, spatial usage and spatial pattern, or the trends in young children's paintings. We would like to mention a few isolated and unrelated statements, comments, or findings that seem illustrative of the manner in which this book is going to continue to dominate in its field. One cannot read it without wanting to initiate a dozen lines of research!

> "Our observations suggest that it is probably less the side of the page emphasized than it is the differential treatment of the left and right sides of the painting page which holds valuable clues for study of personality" (p. 93).
>
> "Other children, instead of progressing quickly from pure experimentation with line and form to realistic representation, persisted in varied and increasingly intricate abstract or structural designs. Careful study of these children suggests that they probably had special abilities along structural lines" (p. 53).
>
> "The rhythmic back-and-forth swing, resulting in a single mass, may, around the age of two, be indicative of an integrated, properly functioning organism, while the broken, scattered strokes made without conscious control may, if persistent or characteristic beyond the ages of one and a half or two, be a reflection of a poorly integrated individual, that is, of an individual who has a poorly integrated neuro-muscular system" (p. 109).
>
> "The dearth of relationships between space usage and developmental changes may be in keeping with our observation that space usage seems to reflect external stimuli and relationships rather than the inner life of the child" (p. 118).

In other words the stimulating quality of the book, and one of the chief reasons for maintaining it will continue to be used for years to come, is that it has not fallen into the snare of so many recent books in the field of child psychology of stating too definite and specific *norms* for too many aspects of personality. Far more harm has been done by the attempts of people to correlate a given child with the norms of one of these psychologists, than can ever be done by someone whose generalizations are given to be used *in relation* with the total available material on the given personality of the specific child. The more we can come to see, in our present state of knowledge, that it is not so much the specific meaning of the separate event, but the relational meaning of a constellation of events, the more are we likely to come to a real understanding of child personality. It is for this reason that *Painting and Personality* deserves praise, for it takes a daring person in this day of cold blooded statistics to present generalizations and say that they must not be indiscriminately applied. For they open themselves to the charge of being unscientific. Yet it may turn out in the end that they are the most scientific of all, for they are studying the results they found and not presenting them in terms of an artificial norm which is only an artifact of the mathematical manipulation of the results found.

That Alschuler and Hattwick have this courage is amply shown in the statistical tables which make up the latter half of Volume II. Pages 381 to 582 present statistic upon statistic, and critical ratio piled upon critical ratio. For those who must see the basic results from which the generalizations were drawn these tables are ample, but surely they add little to the summarization of findings as it is presented in the first volume. The courage, previously mentioned, is shown in the critical ratios. For rarely are these ratios what a "scientific mind" would call "adequate." Yet they are all strong tendencies, and in the present stage of our knowledge of the details of painting, or for that matter the details of personality, it is surprising that there should be consistent strong tendencies. The present writer would like to see some of the stronger tendencies verified by more narrow studies, using children from special circumstances. Would spastic children as a group be differentiated from those whose vision is such that they must be in sight saving classes, or from those who show sufficient intellectual retardation for special class treatment, or those who are sufficient "problems" to be among the patients of a child guidance clinic, or those who are for the first time finding themselves in temporary foster homes or institutions.

The present writer waits, almost with the "bated breath" of the fancier of "soap opera" the next installments, foretold in the footnotes of Volume II. These are the data on crayons, clay, dramatic play, blocks when these held more of interest for the children than the easel painting which is basic to the present study.

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(Murphy, G. Personality. New York: Harper, 1947. Pp. 999.)

Reviewed by C. J. Adcock

This is the most ambitious synthesis yet attempted in the personality field. A vast amount of research material from the technical journals is marshalled here, not as an array of facts, but as a comprehensive account of the genesis of personality. No aspect is neglected and yet the whole is presented as an integrated unity. The "schools" are considered, not to assess their relative importance, but for what they can contribute to the composite picture. The book purports to deal with personality but indeed it covers almost the whole field of psychology since there is nothing of psychological significance which does not contribute to personality.

The innate basis of personality is regarded as a series of biological drives which are conveniently classified into four groups: viscerotonic (e.g., food, sex, maternal), activity (e.g., exercise, rest, sleep), sensory (e.g., delight in color), and emergency (e.g., fear, rage, and disgust). "The personality is apparently definable as a system of tensions or impulses or acts of will" (p. 293). This system is built up as the result of experience which brings about conditioning and canalization. The former process is regarded as operating on the tension system rather than on the specific reflex; the latter is more stable than the former since reinforcement is automatic." A hungry dog may lick the light bulb which symbolizes food. But this does not put an end to his hunger contractions, he does not develop an acquired taste for light bulbs as a preferred means of satisfying hunger" (p. 166).

The system organizes around a central factor: the self. At this stage of knowledge Murphy is content to regard this as an empirical product. Beginning as a unit of perception and experience of struggle it becomes more and more a conceptual trait system under the stress of social approval and disapproval.

Perception is regarded as essentially "autistic" a term taken over from Bleuler but made a little more respectable so that it may be applicable to normal personality. The self perceives the world in terms of its own purposes. Imagination, thought, and dreaming all fit into the same formula.

Much attention is devoted to field concepts. The opening chapter deals with field theory and fuller consideration is given to the same topic towards the end of the book.

A striking feature of the book is the extent to which the viewpoints of the various schools are integrated. The influence of behaviorism is evident in the biological foundation and the environmental molding of the superstructure. In the latter connection the work of the anthropologists is well represented. The gestalt approach is frequently used and never wholly neglected. Purposive psychology is in evidence as in the definition quoted. The return to a McDougallian position commented on by Eyesenck in his review of Sherif and Cantril's *Psychology of Ego-involvement* in this JOURNAL is obvious here. In defining "will" the author says: "For the present we may say, almost as McDougall did, that the will is a group of canalizations (sentiments) organized in behavior terms under the central integrating influence of self-canalizations (McDougall's "self-regarding sentiment").

Reaction against McDougall's teleology and instinct ideas under the influence of early behaviorism has led to considerable misunderstanding of McDougall's real position. It is worthy of note that his system of sentiments is basically the same as what is offered to us by Murphy, and the underlying biological drives are not radically different from McDougall's propensities. The latter were claimed only as drives, capable of expression in diverse ways and open to endless modification by conditioning and what Murphy here calls canalization. Murphy's sex, maternal and food drives are all represented in McDougall as are fear, rage, and disgust. Moreover Murphy admits gregariousness as being evident at least a few weeks after birth and "the child is social to some degree even before he is born" (p. 769). Only in one direction can we imagine McDougall finding fault with this system: no specific provision is made for the propensities of self-assertion and self-abasement.

It is here that the reviewer would like to criticize both the position of Murphy and that of McDougall. The latter based his sentiment of self-regard on the two complementary self instincts and yet described its genesis in terms not essentially different from those of Murphy. In both cases the central factor is the growth of an empirical self which is valued. McDougall's two propensities are irrelevant to this and Murphy entirely dispenses with their function. For the latter there are two essential aspects to the process: the evolution of the empirical self through perceptual and other experience; and the attempt to enhance to self as the result of the impact of social approval-disapproval and narcissism. With regard to the former there is general agreement. In the case of the latter even Allport toys with the idea of a "primitive egoism." Mere expression of approval or disapproval alone cannot account for the results. It is only in so far as social approval has significance for the person that it can operate at all. It may be that this significance arises out of experiences in the satisfaction of simple biological drives but there is room for a very big question mark. As for narcissism we have no indication whether it is to be interpreted in terms of sexual or maternal love. The former could be accepted by few outside the psychoanalytic schools and the latter, if regarded as the major factor, would suggest that women should be more ambitious than men. Murphy here seems to use a Freudian concept without properly relating it to his own system.

The answer to all these difficulties would seem to be suggested by Murphy's own remark that the child is to some extent social even before he is born. Society means something to him because of his biological constitution. He is allied to the dog rather than to the cat. To the reviewer it seems perverse to accept some biologically useful drives and to refuse biological recognition to what is agreed to be the major drive in human living. Adler has here corrected the bias of psychoanalysis and Murphy gives him due credit. Why then refuse to admit a simple biological basis for this major source of motivation? The same evolutionary factors which would lead to the development of innate maternal, anger, and fear drives could give rise to an ego drive which in human beings would tend along social channels. The drive would be directly towards the enhancement of the self and the social environment would provide the frame of reference. We may note in conclusion that McDougall's assertion and submission may reduce to temperament factors as suggested by research into adrenergic-cholinergic balance.

Detailed discussion of all the problems touched on in these 999 pages is obviously impossible and a mere repetition of the table of contents would not be very helpful. The most the reviewer can attempt is some discussion of those topics which most interest him and hope that incidentally he will give some indication of the scope of the book. One topic which we cannot afford to overlook is that of "creativeness." The author pays considerable attention to this noting the conditions under which it appears, its mechanisms and reasons for associating high creativity with madness. Of particular interest is the observation that creativity tends to concern itself with art rather than utility. There is something very significant about this.

Stress on biological utility, homeostasis, etc., has given us a psychology which has tended to reduce what were once regarded as the higher human activities to nothing more than a long circuiting of physiological behavior. A striving for esteem is to be regarded merely as a sort of metaphorical struggle to preserve one's balance and the final sanction for ethics can be nothing but survival utility. This being so it would appear that art is just a biological aberration. How comes it that man, having satisfied his physiological needs to some degree, devotes his energy to non-utilitarian striving? Surely the answer is that he does not live by bread alone; that the aim of living is not merely to go on living but to live more fully. Here is evidence that in some way values are evolved which exist in their own right and are not merely sanctioned by survival utility. It must be admitted that such values could not have negative survival utility, they must not lead to self or racial destruction, but, this granted, such values may themselves become factors in the evolutionary process. That Murphy has glimpsed something of this is a matter for congratulation.

The rôle of culture in the development of personality is another topic that comes in for detailed treatment and much is attributed to this factor. It is stressed, however, that it is not a matter of pouring the personality into the cultural mold but that the individual is an active agent throughout. All rôles are not easily accepted and often considerable strain is involved. This is welcome sanity in a world where so many psychologists see in maladjustment nothing more than a socialization process gone wrong.

The historical study of personality types is of considerable interest as throwing light upon present personality patterns. Since he lacks direct acquaintance with contemporary American culture the reviewer forbears to comment, but the chapter on the fitness of culture is of more general application and is a challenge to all psychologists. The rôle of pure scientist is one to which it is very difficult to keep. All sciences must, sooner or later, make their contribution to ordinary living and psychology owes much to the stimulus derived from its practical application. The evaluation of culture patterns is, however, application on the grand scale and may have far-reaching consequences.

The contrast between western and Soviet patterns is very intriguing at a time when the intensity of the clash between them is so high. Murphy finds three chief assets in the Soviet culture: identification with the group, social security, and freedom for cultural activities. The first is of grave import. Our western culture patterns place a stress on individual competition which creates ego strain which is very obvious when compared with some primitive cultures. One may be doubtful as to how far the Soviet system reduces this strain while still being emphatic that some modification of our own system may be desirable in this connection. Some serious thought as to how our cultural patterns might be improved in the light of anthropological and psychological research would be a welcome change from the narrowly based economic arguments which are so much the fashion at the present time. An interesting speculation is as to the success of social security measures in reducing the feeling of economic insecurity. The considerable developments in this field which is characteristic of Great Britain and a number of the Dominions must surely have had some effects of which psychologists should take note. Murphy comes to no positive conclusions, but his treatment of the whole of this topic is pleasantly stimulating.

With a book of this size and so packed with material it would, perhaps, seem pedantic to complain of omissions but at least one of these deserves comment. The vast development of factor analysis in recent years and the important contributions which it has made towards the understanding of personality would seem to entitle it to more than passing reference.

To sum up: we have here a book which will long remain a landmark in the literature of psychology. In particular it meets the need for a textbook at the advanced level. The greatest lack in the literature of psychology is that of systematic texts beyond the introductory level. May this effort stimulate further work of this kind.

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BOOKS RECENTLY RECEIVED

(There will always be two pages of book titles, listed in the order of receipt, i.e., the most recently received books will be found at the end of the list.)

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ABBREVIATIONS OF WORDS USED IN THE TITLES OF JOURNALS

(One-word titles are never abbreviated. The word "the" is not used, nor its equivalent in any other language. The word "of" or its equivalent in other languages is used only to discriminate what would otherwise be identical titles in different languages. The word "and" is always used but indicated by "&" in the Roman alphabet. Only English words are indicated here, but the corresponding words in other languages should receive a corresponding abbreviation. All abbreviations and all one-word titles should be in italics.)

Abnormal	*Abn.*	Japanese	*Jap.*
Abstracts	*Abst.*	Journal	*J.*
American	*Amer.*	Mathematical	*Math.*
Anatomy	*Anat.*	Measurement	*Meas.*
Animal	*Anim.*	Medical	*Med.*
Applied	*Appl.*	Mental	*Ment.*
Archives	*Arch.*	Monograph	*Monogr.*
Association	*Assn.*	Neurology	*Neurol.*
Attitude	*Att.*	Opinion	*Opin.*
Australian	*Aust.*	Orthopsychiatry	*Orthopsychiat.*
Behavior	*Behav.*	Personality	*Person.*
British	*Brit.*	Personnel	*Pers.*
Bulletin	*Bull.*	Philosophy	*Philos.*
Bureau	*Bur.*	Physics	*Phys.*
Canadian	*Can.*	Physiology	*Physiol.*
Character	*Charac.*	Proceedings	*Proc.*
Children	*Child.*	Psychiatry	*Psychiat.*
Chinese	*Chin.*	Psychoanalysis	*Psychoanal.*
Clinical	*Clin.*	Psychology	*Psychol.*
College	*Coll.*	[illegible]	[illegible]
Comparative	*Comp.*	Quarterly	*Quar.*
Consulting	*Consult.*	Religious	*Rel.*
Contributions	*Contrib.*	Research	*Res.*
Development	*Devel.*	Review	*Rev.*
Educational	*Educ.*	School	*Sch.*
Experimental	*Exper.*	Science	*Sci.*
General	*Gen.*	Social	*Soc.*
Genetic	*Genet.*	Studies	*Stud.*
Indian	*Ind.*	Teacher	*Teach.*
Industrial	*Indus.*	University	*Univ.*
International	*Internat.*	Zeitschrift	*Zsch.*
Italian	*Ital.*		